INTERN EXPERIENCE AT

CH_2M HILL, INC.

AN INTERNSHIP REPORT

by

William John Winter

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ABSTRACT

Intern Experience at CH_2M HILL, Inc. (December 1981)

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A review of the author's internship experience with CH_2M HILL, Inc. during the period September 1975 through May 1976 is presented. During this nine month internship the author worked as an Engineer II in the Industrial Processes discipline of this large consulting engineering firm. The purpose of this report is to demonstrate that this experience fulfills the requirements of the Doctor of Engineering internship.

The author's prime responsibility was as one of three lead design engineers on the design of a large wastewater treatment facility for a pulp mill in Hoquiam, Washington owned by ITT Rayonier Inc. The work generally consisted of the design of individual treatment units and associated piping and pumping. The purpose of the project was to provide wastewater treatment capabilities that would satisfy the effluent limitations (standards) imposed upon the mill by the State of Washington Department of Ecology and the U.S. Environmental Protection Agency.

The author's assignment also entailed necessary interaction with the project manager and other CH_2M HILL design engineers and support staff members, the client's representatives, and representatives of two other consulting engineering firms working on the project. Thus, the internship position at CH_2M HILL provided considerable experience coordinating the author's work with the work of other engineers, guiding

the design and administrative efforts of a support staff, and interacting regularly with the client and other consulting firms. This broad exposure to a variety of engineering and organizational problems provided a valuable educational experience.

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INTRODUCTION

This report describes my Doctor of Engineering internship experience in the Seattle regional office of CH_2M HILL, Inc., a large engineering consulting firm. The internship was officially served over the period September 1, 1975 through May 18, 1976. My internship activities were summarized in monthly letter reports to the chairman of my advisory committee. Excerpts from these reports are contained in Appendix B. The internship supervisor was Mr. John W. Lee, Jr., Manager, Industrial Department.

The purpose of this report is to establish that the objectives of the Doctor of Engineering internship were met. These objectives are:

a. to enable the student to demonstrate his ability to apply his knowledge and technical training by making an identifiable contribution in an area of practical concern to the organization or industry in which the internship is served; and

b. to enable the student to function in a non-academic environment in a position where he will become aware of the organizational approach to problems in addition to traditional engineering design or analysis. These may include, but are not limited to, problems of management, labor relations, public relations, environmental protection, and economics, for example (Texas A&M University, April 1979).

Internship Objectives

Upon entering the internship, it was requested that I submit a set of objectives for the internship period for approval by my employer and my advisory committee. Not knowing that these objectives were to be specifically the objectives of the job assignment, a very general set of objectives was submitted which was more accurately a set of personal goals for the internship. These were:

1. To gain experience in the practical application of my academic background in such areas as engineering design, studies, analysis, and management.
2. To identify areas where further academic background might prove beneficial to my professional development.
3. To gain insight into the workings of the consulting engineering business.
4. To gain experience in dealing with multidiscipline problems and in dealing with professionals in disciplines other than engineering.
5. To satisfy my employer, the clients for whom I work, my fellow employees, and myself that I am capable of quality engineering and that the products of my engineering achieve the desired result in a cost-effective and environmentally sound manner.

These personal goals are restated herein because the extent to which they were met during the internship period is indicative of the value of the experience.

The objectives of the job assignment during the internship were related to my specific project assignment. This assignment was to function as a lead design engineer on the design of a large wastewater treatment facility for a pulp mill in Hoquiam, Washington which was owned and operated by ITT Rayonier Inc. -- the client.

The following were my responsibilities on the ITT Rayonier Waste Abatement Project:

General

1. Hydraulic design of the wastewater treatment portion of the treatment system.
2. Review of hydraulics through the solids handling portion of the treatment system.
3. Review of pump hydraulics and operating points.
4. Design of all major yard piping (larger than 12-inch diameter) and most of the general yard piping (12-inch diameter and under).
5. Evaluation of yard piping materials alternatives.
6. Evaluation of pipe joining and coupling systems.
7. Specification for major yard piping and general yard piping.
8. Initiation of plantsite grading plan and coordination of its completion.

Secondary Clarifiers

1. Design of the following aspects of the secondary clarifiers:
    A. Final water surface elevation

B. Piping into the centerwell

C. Launder dimensions

D. Scum piping

E. Underdrain systems

F. Orientation of walkways to the mechanism drive

G. Stairways to the walkways

2. Selection of piping materials for use under the secondary clarifiers.

3. Coordination of completion of the mechanical design of the secondary clarifiers.

4. Coordination of the structural design of the secondary clarifiers.

5. Coordination of all interaction between CH_2M HILL and the clarifier mechanism supplier.

6. Coordination with the client and other consultants on questions regarding the clarifiers.

Sludge Thickener

1. Similar responsibilities to those for the secondary clarifiers.

Aeration Basin Details

1. Design of modifications to existing primary clarifier.

2. Design of piping in the aeration basin including diffuser systems for both the influent and return activated sludge.

3. Design of pipe crossing details in the aeration basin.

4. Mechanical design of the aeration basin effluent structure.

Aerobic Digester Details

1. Design of floating high-speed aerator layout.
2. Design of mooring details for the aerators.
3. Design of piping in the digester basin.
4. Mechanical design of digested sludge pump station.

Design Drawings

Responsible for preparation, coordination, and/or quality control on the following design drawings:

1. Plot Plan and Index to Drawings
2. Hydraulic Profile
3. General Piping Plan
4. Grading Plan
5. Yard Piping Profiles (4 sheets)
6. Yard Piping Connection Details (2 sheets)
7. Yard Piping - Influent Bypass
8. Yard Piping - Miscellaneous Details
9. Secondary Clarifiers - Area Plan
10. Secondary Clarifiers - General Arrangement
11. Secondary Clarifiers - Plans, Sections, and Details
12. Secondary Clarifiers - Miscellaneous Details
13. Secondary Clarifiers - Structural Plans and Sections
14. Secondary Clarifiers - Mechanism Support Structural
15. Secondary Clarifiers - Structural General Details (2 sheets)
16. Sludge Thickener - (same as for secondary clarifiers)
17. Aeration Basin - Area Plan

18. Aeration Basin - Primary Clarifier Modifications (4 sheets)
19. Aeration Basin - Diffuser Details
20. Aeration Basin - General Details
21. Aeration Basin - Effluent Structure
22. Aeration Basin - Effluent Structure Structural
23. Aeration Basin - Structural General Details
24. Thickener-Digester Area Plan
25. Aerobic Digester - General Arrangement
26. Aerobic Digester - Details
27. Aerobic Digester - Structural General Details
28. Others related to above design responsibilities as they were defined.

Administration

1. Attend project review meetings with representatives of ITT Rayonier as requested by the project manager.
2. Attend meetings with the other consulting firms working on the ITT Rayonier project as requested by the project manager.
3. Prepare minutes of all meetings or portions of meetings which I attended.
4. Receive presentations from suppliers of major equipment to be used on the project.
5. Prepare and circulate technical memoranda on design information presented by major equipment suppliers.
6. Receive presentations by pipe suppliers and answer their questions regarding the project.

The general objective for the internship period was the completion of the above responsibilities to the satisfaction of CH_2M HILL and ITT Rayonier Inc.

The CH_2M HILL Organization

CH_2M HILL is a large multidisciplinary consulting firm with a staff that numbered over 1,000 at the time of my internship. Approximately half of the staff is comprised of professional engineers, planners, economists, and scientists. The firm provides services to industry and government in the fields of civil, environmental, chemical, mechanical, and electrical engineering; urban and regional planning; economic studies; and surveying, photogrammetry, and mapping.

In 1975, CH_2M HILL ranked third in volume of business among national consulting firms that do not provide architectural services. Offices are maintained throughout the United States: Corvallis and Portland, Oregon; Seattle (Bellevue), Washington; Boise, Idaho; Denver, Colorado; Redding, Sacramento, San Francisco, and Newport Beach, California; Reston, Virginia; Anchorage, Alaska; Milwaukee, Wisconsin and others.

The larger offices, including Seattle, are structured into divisions which perform related types of work. The divisions are further subdivided into departments with particular areas of expertise. The division and department system is intermeshed with a discipline (technical quality control) system based on specific project responsibilities. The matrix that results is the basic organizational structure of CH_2M HILL.

The Intern's Position Within the Organization

I worked in the Seattle regional office, which had 159 full-time employees at the time of my internship. I was assigned to the Industrial and Energy Systems division, the Industrial department, and the Industrial Processes discipline. The Industrial department consisted of seven engineers, all with sanitary (environmental) or chemical engineering backgrounds. The department's work is primarily related to the study and design of treatment processes and systems to serve industrial wastewater dischargers. John Lee, my internship supervisor, was the department manager.

I worked at the grade of Engineer II, which is generally thought of as requiring at least 3 years of prior engineering experience. From job description information used by CH_2M HILL, the following general features of work performed at this level were extracted:

1. Application of standard techniques, procedures, and criteria in carrying out a sequence of related engineering tasks.
2. Supervisor screens work to eliminate the most difficult problems and selects techniques and procedures -- Engineer II receives close supervision on new aspects.
3. Engineer II uses prescribed methods on specific and limited portions of broader assignment of experienced engineer.
4. Supervision of Aides, Technicians I, and Technicians II.
5. Limited exercise of judgment.
6. Developing client contact.
7. Developing judgment.

Some examples of work performed at the Engineer II level are:

1. Hydraulic analysis and design of small distribution and transmission systems.
2. Analysis and design of pump stations and specific elements of water and wastewater treatment systems.
3. Collection, tabulation, and analysis of sections of feasibility studies.
4. Review and checking plans and specification writing.
5. Analysis of laboratory and field tests.
6. Analysis of bids.

The Intern's Project Assignment

CH_2M HILL was hired by the Grays Harbor Division of ITT Rayonier Inc. to design an air activated sludge wastewater treatment system for their pulp mill in Hoquiam, Washington. The mill is a 500 A.D. (air dry) ton per day acid sulfite facility which was previously served by only a large primary clarifier. Primary solids were dewatered on a coil-type vacuum filter and trucked to a landfill. Effluent was discharged to the Grays Harbor estuary.

A bench-scale treatability study was conducted by CH_2M HILL in early 1975. The results of the treatability study along with the influent (primary clarifier effluent) characteristics below were the basis for treatment process selection and design. Influent characteristics were provided by ITT Rayonier.

	Min.		Max.
Flow, MGD	21		33
pH	3.0		9.0
BOD, ppm	440		1,030
Temperature, °F	50		100
Turbidity, JTU	15		70
Total Dissolved Solids, ppm	1,700		3,000
Total Suspended Solids, ppm	130		530
Suspended Combustible Solids, ppm	60		420
Toxicity		NONE	
Sewage		NONE	
Temperature Differential °F (above receiving water)	37*		65*

	Avg.
Chloride, ppm	450
Sodium, ppm	450
Iron, ppm	2
Copper, ppm	Trace, ∿ 0.04
Mn, ppm	0.30
Zn, ppm	0.2
Total Sulfur, ppm	160
Sulfate Sulfur, ppm	120

*These are the maximum/minimum receiving water temperature. ΔT to be calculated by CH_2M HILL based on their estimation of effluent temperature.

The treatment process design was completed in the study phase of the project in June 1975. The selected treatment processes (liquid and solids) and their respective design criteria are summarized below:

Aeration Basin

Flow	27 MGD
BOD applied	170,000 lbs/day
BOD removal	95-98 percent
F/M	0.35
lbs O_2/lb BOD_R	1.25
lbs TSS/lb BOD_R	0.4
Alpha	.75
Beta	.95
Basin volume	23.4 MG
Depth	20 feet
Detention time	21 hrs
MLSS	Approx. 2,300 mg/l
Sludge age	Approx. 9 days

Temperature	30°C
Minimum DO level	1.5 mg/l

Clarifiers

No.	3
Diameter	150 feet
Overflow rate	500 gpd/ft^2
Solids loading @ 100% recycle	20 lbs/$(ft)^2$(day)
Recycle solids conc.	1-2 percent

Aeration Basin Aerators
(Kenics Aeration System)

Oxygen transfer (at standard conditions)	330,000 lbs O_2/day
No. of Kenics aerators	3,072
No. of blowers	5
Horsepower/blower	900-1,000

Aerobic Digester

Volume	6-11 MG
Water depth	9-15 ft (variable)
Sludge age in digester	15 days (variable)
Aerator type	High speed
Aerator horsepower (total)	900
No. aerators - horsepower	12-75 hp
Mixing power level @ 12.8 ft depth	Approx. 100 hp/MG (variable)

Sludge Thickener

Diameter	70 feet
Side water depth	10 feet
Solids loading	12 lbs/$(ft)^2$(day)
Underflow solids concentration	2-3 percent

Based on influent characteristics and process design criteria, CH_2M HILL predicted the following effluent characteristics:

	Min.	Avg.	Max.
Flow - MGD	21	27	33
pH	6.5	7	7.5
BOD - ppm	66	110	154
Temp. - °F	50	80	90
Turbidity - JTU	5	10	50
Total dissolved solids - ppm	500	700	900
Suspended combustible solids - ppm	20	70	100

	Avg.
Chloride - ppm	450
Sodium - ppm	450
Iron - ppm	2
Copper - ppm	Trace
Mn - ppm	.03
Zn - ppm	.2
Total sulphur - ppm	160
Sulfate - ppm	.2
Nitrate - ppm	.5
Phosphate - ppm	.5

Effluent of this quality would comply with the following discharge permit requirements which ITT Rayonier was to meet beginning March 1, 1977:

BOD - 30,300 lbs/day average, 36,000 lbs/day maximum

Total suspended solids - 14,900 lbs/day average,
29,800 lbs/day maximum

Toxicity - the 96-hour TL_{100} for any salmonid test fish shall exceed 65 percent concentration of the effluent

pH - 6.0 to 8.5

Floating solids or visible foam - none other than trace amounts

The Intern's Position on the Project Team

The beginning of my involvement in the ITT Rayonier project in July 1975 was concurrent with the beginning of the design effort on the treatment system hardware. The project was large in terms of engineering and construction costs -- approximately $500,000 worth of engineering and $8,000,000 worth of construction (1976 dollars). In spite of the engineering effort involved, CH_2M HILL's full-time project team consisted only of the project manager and three lead design engineers, of which I was one. Technical support services, such as soils and foundations, structural, electrical, and mechanical engineering were provided throughout the duration of the project by at least eleven other engineers on a part-time or short-duration full-time basis. A non-professional support staff of technicians, draftspersons, graphic artists, clerks, and secretaries were available on an "as-needed" basis.

The project manager and the lead engineers were all from the Industrial department. The project manager was also the department manager and as such had to divide his time between two responsibilities. Under these time constraints, he found it necessary to concentrate on project scheduling, progress reports, billings, and client contact. This type of project structure allowed me to gain considerable experience coordinating design efforts by the support groups in my areas of responsibility.

In addition to coordinating the design work of others, my contribution to the project included design of individual treatment unit hardware and associated piping and pumping. The other lead engineers had similar responsibilities. With the small full-time design staff, I had the opportunity to carry to completion the design of several different treatment units. Also, preparation of specifications was delegated almost completely to me and one other lead engineer.

The following summary of the CH_2M HILL staff involved in the ITT Rayonier project should further define my position on the project:

Position or Discipline	Level	Project Status
Project Manager	Engineer V	Part-time throughout
Lead Engineer (myself)	Engineer II	Full-time throughout
Lead Engineer (Industrial Processes)	Engineer II	Full-time throughout

Position or Discipline	Level	Project Status
Lead Engineer (Industrial Processes)	Engineer III	Full-time throughout
Industrial Processes Engineer	Engineer II	Short duration full-time
Mechanical Design Engineer	Engineer IV	Short duration part-time
Mechanical Design Engineer	Engineer III	Short duration part-time
Mechanical Design Engineer	Engineer II	Short duration part-time
Mechanical Design Engineer	Engineer I	Short duration full-time
Structural Engineer	Engineer VI	Part-time throughout
Structural Engineer	Engineer II	Part-time throughout
Structural Engineer	Engineer I	Short duration full-time
Soils Engineer	Engineer IV	Part-time throughout
Electrical Engineer	Engineer III	Short duration part-time
Electrical Engineer	Engineer II	Short duration part-time

Two other consulting firms also provided services on the ITT Rayonier project. A large geotechnical consulting firm completed a soils investigation report on the site, developed preload design criteria, developed soils bearing capacities for the various structures, and recommended foundation designs. A small multidiscipline engineering firm did the electrical design for the treatment system. It was necessary for me to interact regularly with these organizations during the course of my design work on the project.

DESIGN RESPONSIBILITIES

General

A major set of internship objectives was met through the accomplishment of the several "general" design responsibilities. These responsibilities essentially affected the entire waste abatement facility rather than individual wastewater treatment units.

Four of these responsibilities (see section General, page 3) involved hydraulic design principles for piping and/or pumped conveyance systems. My approach to these tasks was to first review the considerable amount of project background information that had been gathered prior to my assignment to the project. Drawing on basic engineering principles and previous experience with this type of design, I prepared a layout of the entire plantsite at a scale of 1" to 100'. The plantsite layout was used to show the general orientation of the treatment units and to identify problem areas which might impact the piping system design. Many of the trouble spots were eliminated at this stage after consultation with more experienced CH_2M HILL engineers and meeting with the client's engineers.

The plantsite layout drawing was then subdivided into several smaller areas. Area plans (1" to 20') were developed for purposes of horizontally locating the pipelines and identifying many of the bends, valves, and miscellaneous fittings that would be required. A review of many personal and in-house references on hydraulic design was conducted and design factors were then selected. This information along with the capacity requirements defined in the predesign stage of the project was used for rough sizing of the major pipelines. At this point, I was introduced to a valuable design tool that was used throughout the project -- a CH_2M HILL computer program called HYDRO. This program is used in the design of all types of piping systems and the sizing of hydraulic elements commonly encountered in water and wastewater treatment plants. A summary statement on the capabilities of HYDRO is contained in Appendix C.

The capacities, system geometry, and design factors for each pipeline were loaded into the computer system. The output of the HYDRO program indicated the rough operating water surface elevations for the major treatment units. Selected piping systems were checked manually to verify both the accuracy and my understanding of the program. Based on my experience, safety factors were established and applied to the rough water surface elevations to derive preliminary design elevations. These elevations were reviewed with appropriate project technical consultants to verify their acceptability. Work on the major treatment units was then initiated using the preliminary design elevations as the basis.

It was also my responsibility to review the hydraulic design of the solids handling portion of the treatment system, which was completed by another consulting firm, and the pump hydraulics calculations and operating point selections of the other CH_2M HILL engineers. HYDRO was again used in this review process. The system capacities, geometries, and appropriate design factors were input to the computer system. The HYDRO output was compared with the designs of the other engineers to verify that their preliminary results were reasonable and contained no major errors. Where discrepancies were found, adjustments were made as necessary. Professional disagreements were resolved by the client or by the project manager.

To complete the design of the "major yard piping" (larger than 12-inch diameter), profile drawings of each pipeline were prepared. Yard piping design for wastewater treatment facilities is not typically carried to this level of detail. However, I suggested that profiles be prepared because the pipelines were large, the site was crowded, and some of the piping fittings were necessarily complex. The profile drawings proved to be of great assistance to the pipe fabricators and to the construction contractors. ITT Rayonier has subsequently required the preparation of profile drawings for other major pipelines in congested areas on similar projects.

After in-house and client review and appropriate revision of the profile drawings, all of the information for final hydraulic design of the yard piping was available. Again, HYDRO was used to complete the final design. At this point, the HYDRO output provided the best predictions of water surface elevations at each major treatment unit. These predictions were compared with the preliminary design elevations set previously to verify that the safety factors used were adequate. Selected piping systems were again checked manually to verify the accuracy of the program and to confirm that the design data were input properly. After final review in-house and consultation with the client's engineers, the elevations of the major treatment units were set.

The HYDRO program was used on many occasions as detailed design of the treatment units progressed. Because the input data is stored on disc, the impact on the hydraulic design of minor structural or mechanical design changes could be quickly checked.

My general responsibilities on the ITT Rayonier waste abatement project also included coordination of the process of selecting the piping materials for the various pipelines. The approach taken in accomplishing this task was first, to solicit input from the client's engineers on their initial preferences for the various piping applications; second, to gather information on CH_2M HILL's experience with and preference for piping materials for similar applications; third, to screen the alternatives on the basis of client preference and CH_2M HILL experience and select candidate piping materials for the various applications; and fourth, where the size of the pipeline warranted, to initiate an economic analysis of the candidate materials.

The economic analyses were accomplished working with CH_2M HILL's cost estimating department. The findings of the analyses were presented and discussed at several meetings with the client's engineering staff. They were also discussed with several of CH_2M HILL's senior engineers in various offices. The content of these discussions were the basis upon which final materials selections were made by the client.

A similar approach was taken in fulfilling my responsibility for evaluation of alternative pipe joining and coupling systems. Once selection of the joining systems and piping materials was made by the client, the preparation of piping specifications could begin. This task became another of my general design responsibilities.

Two sets of piping specifications were developed. One set covered major yard piping (over 12-inch diameter) and a second specification was for "general yard piping" (12-inch diameter and under). My approach to this task was to first review similar specifications previously prepared by the client. The intent of the review was to gain some insight as to what was acceptable to ITT Rayonier in terms of format, content, and extent of coverage.

For a general yard piping reference, ITT Rayonier directed me to their standard piping specifications for the Hoquiam mill. This information was supplemented by that contained in CH_2M HILL's master specifications for the selected piping materials. The master specifications are stored on computer disc and printouts were ordered and reviewed in detail.

To prepare the major yard piping specification, a third source of information was sought. I contacted several reputable manufacturers of the selected piping material and requested copies of their sample specifications. Although these were too general to be directly applicable, the sample specifications did provide information on the national standards (ASTM, AWWA standard specifications, etc.) that the best piping was currently being designed to meet.

As I developed the specifications, they were reviewed at several meetings by ITT Rayonier's engineers. CH_2M HILL senior engineers also reviewed them prior to their final release to the client. In final form, the major yard piping specifications were submitted through the client's purchasing department to qualified pipe suppliers with an invitation to bid for the right to supply the pipe. The general yard piping specifications were used by ITT Rayonier's engineers and construction managers to purchase these materials directly (without requiring bids) from suppliers as the need arose during construction.

A copy of the major yard piping specifications is contained in Appendix D. The general yard piping specifications are not included in this report because they draw heavily from ITT Rayonier standard specifications. Their publication could presumably violate confidentiality agreements between CH_2M HILL and ITT Rayonier.

When bids were received on the major yard piping, I participated in the analysis of the bids. However, my involvement was limited to assessing the compliance of the bidders' proposals with the technical aspects of the specifications. This restriction was imposed by the client because of the delicate and confidential nature of the negotiation procedure that ITT Rayonier follows with its suppliers. Exceptions to the specifications were tabulated and forwarded to the client without recommendations.

A final responsibility in the "general" category was initiation of the development of a plantsite grading plan, and coordination of its completion. I was assigned this responsibility because the hydraulic design previously discussed was the determining factor in setting the elevations of the major treatment units. These elevations in turn significantly influenced the grading plan concept.

My approach on this task was to discuss with the client's engineers their philosophy on surface runoff control, drainage considerations, and paving requirements. Their input was reduced to paper in the form of a marked-up plantsite layout drawing (1" to 100') which subsequently received several iterations of review and modification. When the preliminary concepts were firmly established, finalization of the grading plan design was assigned to a senior civil engineering technician. I coordinated the design process and determined the manner of graphic presentation, including the number of design drawings, scale and format of the drawings, and the sections and details required. I also served as the liaison between the technician involved and the client, answered or obtained answers to questions, and coordinated both the in-house and client review procedures.

Secondary Clarifiers

Completion of the design of three 150-foot diameter secondary clarifiers was a major objective of the internship. These treatment units are circular concrete tanks which retain the wastewater in a quiescent condition. This allows for removal of biological solids from the wastewater by gravity settling. With the exception of the structural design of the tanks, I was responsible for the design of all aspects of the clarifiers. These responsibilities are identified in the section Secondary Clarifiers, page 3.

Secondary clarifiers are treatment units commonly encountered in wastewater treatment facilities. As such, CH_2M HILL had designed literally hundreds of them. Consequently, my approach to this task centered on a review of several recent designs which had been successfully constructed in Pacific Northwest. Using these as a guide, a preliminary list of the plan, section, and detail views that should be included in the final design drawings was developed. This list was reviewed with the project manager to obtain his approval. Working from the approved list, I prepared the following worksheet drawings (scale drawings done in graphite on velum) incorporating the sizing and orientation appropriate for and unique to this particular application:

1. A composite section of the secondary clarifier tank, mechanism, and piping.
2. Plans showing the orientation of the mechanism support pier and the center sludge hopper.
3. A typical wall section showing footing, effluent launder (trough), weir, and top of wall elevations and wall thickness and launder width.
4. A plan and sections of the outlet box through which the clarified wastewater passes from the launder to the effluent piping.
5. A plan, section, and detail of the stairways required for access to the clarifier walkway bridges.
6. A detail of the underdrain system that is required to eliminate hydrostatic uplifting pressures when dewatering the clarifier tanks.
7. A detail showing scum removal piping through the clarifier walls. (Scum is foam, floating debris, etc. skimmed from the liquid surface in the clarifier.)
8. A detail of the clarifier scum baffle and weir.

After a cursory in-house review, the worksheets were presented to the client for comments. The comments were significant and necessitated major revision of the preliminary design concepts. Nonetheless, the input from the client's engineers was very valuable. Their lack of exposure to these treatment units enabled them to take a fresh look at design features that had gone unquestioned for years and consequently had become standardized in CH_2M HILL's design practice. In my opinion, the result was an improved and more rational design with regard to many of the common features of secondary clarifiers.

Once the revised design concepts and worksheets were reviewed and approved by the client, my task of coordinating the structural design of the secondary clarifiers began. A structural engineer was assigned to this portion of the project. Generally, his design effort consisted of reviewing the mechanical design worksheets, developing similar structural worksheets, sizing the reinforcing steel, and adding the steel and the structural details to the structural worksheets. His review of the mechanical worksheets included checking my estimates (based on the review of previous designs) of wall, slab, footing, and center pier dimensions. My role in the structural design process was to convey the approved mechanical design concepts, serve as a liaison between the structural engineer and ITT Rayonier's engineers, answer or obtain answers to questions, and coordinate both the in-house and client review procedures.

A unique concept had to be incorporated into the structural design of the secondary clarifiers because the soils conditions at the project site were very poor. ITT Rayonier's geotechnical consultant had completed a soils investigation and predicted that significant settlement of the clarifiers would occur unless they were constructed on piling. After lengthy discussions and much deliberation, the client ruled out construction on piling for economic reasons.

With excessive settlement anticipated and considerable differential (different areas of the clarifiers settling at different rates) settlement also probable, the typical structural design concept of a continuous circular tank, deriving its structural integrity from hoop strength, had to be abandoned. In response to the problem, CH_2M HILL's structural engineers developed an articulated design concept. The clarifiers were structurally broken down into several "pie-shaped" segments. The segments were then designed as a series of independent retaining walls which would be constructed in a circle to form the individual clarifier tanks. Rather elaborate expansion joints with oversized water stops were designed for the interfaces between the segments. The unique design allowed the segments to settle somewhat independently while still preserving the integrity of the entire structure. This innovative concept was a major factor contributing to selection of the ITT Rayonier waste abatement project for an honorable mention award in the Consulting Engineers Council of Washington Engineering Excellence Competition.

Since excessive settlement of the secondary clarifiers was anticipated and structurally designed for, it was also necessary to design the piping under the clarifier floor slabs for this rather severe condition. My approach to this problem began with another review of recent CH_2M HILL designs. The better of the previously used concepts were selected as alternatives. The alternatives were then modified as required to withstand the anticipated settlement. As a next step, I discussed the design conditions with and sought the input of several of CH_2M HILL's senior engineers, the client's engineers, and the engineering staff of the piping supplier selected for the major yard piping contract. Using this input, the alternatives were finalized and presented to the client. At successive meetings, the alternatives were further analyzed and discussed, and through the process of elimination a design concept was selected. My previous design experience on a large submarine outfall pipeline project proved valuable in formulating the alternatives.

I was also assigned the responsibility of coordinating interaction between CH_2M HILL and the manufacturer of the secondary clarifier mechanisms. My coordination function was focused in three areas: (1) reviewing the mechanism manufacturer's shop drawings to assure compliance with the secondary clarifier specifications prepared by CH_2M HILL, (2) answering or obtaining answers from the manufacturer for all questions pertaining to the clarifier mechanisms that were raised by CH_2M HILL personnel, and (3) working with the manufacturer's representative to assess the implications of excessive settlement on the mechanical, process, and hydraulic design of the clarifiers.

Prior to commencing the review of the manufacturer's shop drawing submittals, I discussed with both CH_2M HILL's project manager and ITT Rayonier's project manager their concept of the assignment and the procedure to follow. Suggestions were also solicited from other CH_2M HILL design engineers who had previously performed a similar function on other projects. From the discussions, I concluded that my responsibility was to review the submittals for compliance with the intent of the specifications. To carry out this function, I first read the specifications thoroughly. Written submittals and the notes on all submittal drawings were then compared in detail with the specifications. Also, all specified dimensions and sizes were checked. Discrepancies were appropriately noted on the submittals, and each submittal item was stamped either "NO EXCEPTIONS NOTED," "MAKE CORRECTIONS NOTED," "REVISE AND

RESUBMIT," or "SUBMIT SPECIFIED ITEM." The discrepancies were discussed with the client and the submittals were then returned to the manufacturer through ITT Rayonier's purchasing department. A copy of each reviewed submittal was routed to all project personnel that were expected to interface with the secondary clarifier design. Generally, the required corrections to the submittals were completed by the manufacturer after one iteration of the review process. However, as many as five iterations were required on some of the more complex submittals.

The client requested that I coordinate an assessment by the secondary clarifier mechanism manufacturer of the implications of excessive differential settlement of the clarifier tanks. The assessment was to address impacts on the mechanical, process, and hydraulic performance of the clarifiers. I contacted the manufacturer's representative and requested that he attend our next project review meeting. He was asked to be prepared to discuss the adverse effects of differential settlement on the clarifier mechanisms and how to minimize these effects. A meeting ensued during which the manufacturer presented a summary of his assessment. Subsequently, he was asked to prepare and submit a priced proposal detailing adjustability features that could be built into the mechanisms to compensate for the anticipated settlement. The proposal was submitted and the client asked that I review it. Before commencing the review, I discussed the situation with several of CH_2M HILL's senior engineers. It was concluded that the magnitude of the settlement problem made it unique in the firm's experience. As such, my review became an exercise in basic engineering intuition. My review comments were presented to the client and the manufacturer was asked to incorporate some of them into a revised proposal. ITT Rayonier subsequently decided not to accept the proposal.

Two final responsibilities related to the design of the secondary clarifiers were: (1) to coordinate the design efforts of two mechanical engineers assigned to the project for a short duration, and (2) to answer or obtain answers to questions by the client (or the other consulting firms working on the project) regarding the clarifiers. The two mechanical engineers were assigned to the ITT Rayonier project at the project manager's request. He wanted to reduce my design workload so that I could concentrate more fully on project coordination and my administrative assignments (See section ADMINISTRATIVE ASSIGNMENTS, page 38). Since their assignment was for a short duration, information was provided to these two engineers on a "need to know" basis. As their work progressed, I acquainted myself with their general design concepts and served as a liaison between them and the client. I answered or obtained answers to their questions and coordinated both the in-house and client review of their work.

In the initial stages of the internship, the manufacturer had to answer most of the client's questions regarding the secondary clarifier mechanisms. However, as the design progressed and shop drawing submittals were reviewed, my knowledge and understanding of the principles of clarifier mechanism fabrication, installation, and operation expanded significantly. In the latter stages of the internship period, neither the manufacturer nor other CH_2M HILL engineers had to be relied upon for explanations and answers. The understanding of these treatment units that I had gained through the design process made me nearly self-sufficient in fulfilling this responsibility and meeting this objective.

Sludge Thickener

An objective of the internship that was not met was the design of a sludge thickener. A thickener is physically very similar to the secondary clarifiers described above. Sludge previously removed from wastewater in clarifiers is often introduced into a sludge thickener. The thickener provides quiescent conditions which allow for further separation of solids and liquid by gravity settling. The additional separation results in a thicker sludge.

ITT Rayonier unilaterally made the decision to eliminate the sludge thickener from the scope of their waste abatement project. Although CH_2M HILL was informed of the decision at a point well along in the project schedule, design of this unit had not begun since an authorization to proceed had not been communicated by the client.

Aeration Basin Details

The aeration basin is the heart of most biological wastewater treatment systems. It is in this unit that the bulk of the organic pollutants in the wastewater receive treatment. An objective of the internship was to design the hydraulic conveyance systems into and out of this important treatment unit. There were three separate systems to consider in meeting this objective. Their respective functions were: (1) to introduce the influent wastewater into the aeration basin, (2) to distribute the "return activated sludge" (a portion of the sludge removed in and pumped back from the secondary clarifiers) in the aeration basin, and (3) to allow for the effluent wastewater to exit the aeration basin.

Development of the influent system included the design of modifications to the client's existing primary clarifier. The existing outlet from the primary clarifier had to be converted to an emergency overflow and the existing emergency overflow converted into the normal outlet. These modifications were a result of and an extension of the hydraulic design work discussed in the section General. The computer program HYDRO was again employed as a design tool.

The conversion of outlet to overflow, and vice versa, was primarily a problem of weir hydraulics and weir plate design. Several personal and in-house references were reviewed to determine the appropriate weir hydraulics formulas and coefficients for this application. This information along with flow requirements, design factors, and the geometry of the primary clarifier were input to HYDRO. The output established the weir crest elevations to be used in the design. The results were spot checked manually and then reviewed with the project manager and the client. After setting weir crest elevations, some conceptual designs for the new weir plates were developed. These were then presented to the client and refined during a project review meeting. The final design of the weir plates was assigned to one of CH_2M HILL's project structural engineers.

Another aspect of the outlet/overflow conversion problem was the design of a replacement for an existing "insert" in the primary clarifier wall. The new insert was to be a similar fabricated stainless steel item. It was also to be cast into the primary clarifier wall in the location of the existing insert. The wastewater would then leave the clarifier and enter the piping to the aeration basin via the new insert. The hydraulic transition from open channel flow in the clarifier outlet box to full conduit flow in the downstream piping was to be made in the insert.

The design was accomplished using the existing insert as a guide. However, capacity requirements and other hydraulic constraints made it necessary to enlarge and improve upon the previous design. The improvements focused on reducing the hydraulic energy loss at the entrance to the insert, but the size of the entrance (60" x 30") and the materials of construction required for the insert (316L stainless steel) imposed economic restrictions which limited the set of feasible designs. A large metal fabricating company was consulted as to the economics of the alternatives. Using the previous design, input from the fabricator, and review comments from the client and other CH_2M HILL engineers, a design concept was selected and developed.

The hydraulic characteristics of many types of curved and straight entrances have been the subject of detailed laboratory analysis. The results of these analyses are readily available. However, the entrance design selected for the new insert was necessarily unique so pertinent information on its hydraulic characteristics was not readily available. The energy loss at the entrance to the insert had to be estimated using data on other types of entrances. Since the accuracy of such an estimate was unknown, it had to be very conservatively made. Given less restrictive economic constraints and a more flexible project schedule, it would have been desirable to analyze the hydraulic characteristics of the new insert in the laboratory.

A major element of the aeration basin details work was the design of distribution piping for both the influent wastewater flowing from the primary clarifier and the return activated sludge pumped from the secondary clarifiers. Efficient operation of the treatment system requires that these two process streams be introduced into the aeration basin in a manner that results in relatively even distribution. The approach to this task involved the application of another of CH_2M HILL's many computer programs and one with which I had previous experience. The program is referred to as DIFF.F4 which stands for diffuser analysis in Fortran IV. It was originally developed by the Environmental Protection Agency and later modified and expanded by CH_2M HILL. I had used DIFF.F4 previously to design a large submarine diffuser/outfall to discharge domestic sewage.

A diffuser is a submerged manifold or section of pipe with multiple ports (holes) through which the pipe contents are jetted under pressure. The velocity of the jet causes turbulent mixing of the diffused liquid with the surrounding water. The CH_2M HILL design team in conjunction with ITT Rayonier's engineers decided that separate diffusers were the appropriate means for obtaining thorough distribution of the influent wastewater and the return activated sludge in the aeration basin.

It was necessary to use an iterative approach to the design of the two diffusers. First, my collection of technical literature on diffuser design was reviewed. "Rules of thumb" from the literature were used as a guide in developing preliminary layouts of the diffusers and in selecting preliminary pipe sizes, port sizes, port spacings, and numbers of ports. This information, along with capacity requirements and design factors used in the HYDRO program analyses, was input to the DIFF.F4 program. The output provided detailed hydraulics data from the analyses of the diffusers, including the velocity and headloss (energy loss) in the various pipe sections, the flow discharged through each port (which varies), and the headloss through each port. Finally, the output for each diffuser was compared with the project hydraulic constraints and adjustments were made, leading to another iteration of the design process. In the end, the design of the diffusers entailed determining the "optimal" combination of pipe size, port size, port spacing, and number of ports such that mixing and distribution are sufficient while headloss is not excessive. Selected computer calculations were checked manually to verify the accuracy of the DIFF.F4 programming.

The selected design concept called for placement of the two diffusers parallel to each other and at the center of the aeration basin. Since a great deal of aeration piping also had to be installed on the bottom of the basin, the diffusers were located in close proximity to each other. This and other site constraints made it necessary for the return activated sludge pipeline to cross under the influent wastewater diffuser at the center of the aeration basin. Due to the size of the pipelines (48 and 30 inches in diameter) and the other constraints, this under-crossing had to be very accurately designed. Using the pipe manufacturer's catalog and information obtained by telephone from their engineering department, a preliminary design was developed. All of the locational coordinates and dimensions were independently checked by another CH_2M HILL engineer assigned to the project.

Upon completion of the preliminary work on the diffusers and the pipe crossing, the designs were presented to the client and the design procedure explained. ITT Rayonier's engineers had little experience with diffuser design and, therefore, requested only that CH_2M HILL's normal internal review be conducted. The design was reviewed by appropriate project technical consultants.

A structure was required to provide a means for the wastewater to exit the aeration basin and flow to the secondary clarifiers. Additionally, it was necessary to split the aeration basin effluent flow evenly between the three secondary clarifiers. In the initial stages of the design, these two problems were addressed separately. Effluent structures and flow splitting structures from previous CH_2M HILL designs were reviewed and some textbook designs were also considered. Various combinations of the different types of the two structures were developed and presented to the client as alternatives. Eventually, it was decided that it would be most economical to solve both problems with one structure. Working from the ideas presented in the project review meetings and the concepts gleaned from other designs, preliminary worksheets of the aeration basin effluent structure were developed. The selected design concept called for a concrete structure constructed in the earthen dike wall of the aeration basin. The structure included three weirs of equal length to accomplish the flow split between the secondary clarifiers and also to maintain the desired water surface elevation in the aeration basin. The experience with weir hydraulics that was obtained while designing the primary clarifier outlet/overflow conversion also proved most helpful in completing this design task.

After the preliminary worksheets were reviewed by the client, the detailed mechanical design of weirs, gates, gate operators, and inserts was completed and handrail locations were determined. Subsequently, the structural design was initiated and coordination between mechanical and structural design efforts was undertaken in a fashion similar to that employed on the secondary clarifier design. My estimates of wall, footing, and other structure dimensions were checked, the reinforcing steel was sized, and the structural details were developed. I conveyed to CH_2M HILL's structural engineer the previously established mechanical design concepts, served as a liaison between him and ITT Rayonier's engineers, answered or obtained answers to questions, and coordinated both the in-house and client review procedures.

Aerobic Digester Details

An aerobic digester is a basin or tank in which sludge is stabilized and reduced in volume by biological degradation. Sludge previously removed in the clarifiers (and sometimes previously thickened in a sludge thickener) is introduced into the digester basin where aeration is provided for mixing and to satisfy the oxygen requirements of the microorganisms in the sludge. The microorganisms consume their own cell material as a food source, thereby stabilizing and reducing the volume of sludge.

The design of an aerobic digester was an objective of the internship that was not met. The responsibilities associated with this objective were not undertaken due to a decision by ITT Rayonier to eliminate the aerobic digester from the scope of their waste abatement project. The circumstances surrounding this scope reduction are similar to those discussed in the section Sludge Thickener.

Design Drawings

Along with the specifications, the end products of the design phase of an engineering project are the design drawings. My internship design responsibilities resulted in the production of the design drawings listed in the section Internship Objectives, pages 5 and 6. An objective of the internship was preparation, coordination, and/or quality control on these drawings.

The production of a design drawing was typically initiated by developing a worksheet. The worksheet essentially constituted a mockup of the desired design drawing. The various plan, section, and detail views that comprised the worksheet came primarily from "graphite on velum" scale drawings which I prepared. Reduced, enlarged, or to scale photocopies of portions of previous design drawings were also used on occasion. The previous designs used in the preparation of the ITT Rayonier drawings were almost entirely CH_2M HILL's. However, the client did provide some standard details and drawings from previous projects for reference. Also, some textbook sketches were used as a guide. Almost without exception, the previous designs and textbook information used had to be modified to meet the unique and specific requirements of the ITT Rayonier project.

Drafting of the worksheets was accomplished by CH_2M HILL's Engineering Graphics department. The department's work was done in ink on 22" x 34" Mylar sheets provided by the client. CH_2M HILL firm-wide graphics standards, policies, and procedures were used unless directed otherwise by ITT Rayonier.

All engineers and design technicians worked only on prints of the Mylar originals. The designer was responsible for engineering accuracy on his drawings and shared the responsibility for drafting quality with the manager of the Engineering Graphics department.

Quality control and coordination were significant tasks, especially when the designs of two or more engineering disciplines were to be depicted on one drawing. As a lead engineer, it was my responsibility to insure that the drawings assigned to me received the appropriate technical review. It was then necessary for the in-house and client review comments on the designs of all disciplines to be addressed and resolved. Any design changes that resulted had to be accurately incorporated into the final design drawings before their release to the client. Also, ITT Rayonier's preferences as to materials of construction, construction details, and design style had to be utilized where appropriate. In sum, I was responsible for the client's satisfaction with all aspects of the design drawings that were assigned to me.

To accomplish the quality control and coordination tasks, a procedure for assigning and checking the drawings evolved. Each of the three lead engineers (and the project manager when available) became a designated reviewer for a portion of the design drawings. The breakdown of this responsibility was on the basis of the various treatment units and facilities comprising the wastewater treatment system. Worksheets and sketches underwent a concept review by the appropriate lead engineer before presentation to the client. Once drafted, the drawings were reviewed for graphical quality by the appropriate lead engineer before presentation to the client. After review by ITT Rayonier, the drawings were again checked by the designated reviewer to assure appropriate action had been taken by the designer in response to the client's comments. Although this procedure was time-consuming and seemed repetitive and overly cautious, it became critical to the continued satisfaction of the client. Implementation of the assigning and checking procedure made possible the accomplishment of the coordination and quality control objective.

ADMINISTRATIVE ASSIGNMENTS

In addition to the design responsibilities previously discussed, I was assigned certain administrative responsibilities on the ITT Rayonier waste abatement project. A second set of internship objectives was met through the performance of these administrative assignments.

Project Review Meetings

As may be apparent from the foregoing discussion of my design responsibilities, the client was very actively involved in the design process. ITT Rayonier's project manager and liaison team felt that it was important for them to know about every aspect of the ongoing design work, primarily to facilitate their scheduling of construction activities. The liaison team believed that frequent project review meetings best enabled them to maintain a working knowledge of the status of the design process. One of my administrative assignments during the internship was to attend these meetings as requested by CH_2M HILL's project manager.

The client scheduled project review meetings at least once per week, and sometimes two or three times per week during the peak of the design activity. The meetings typically consumed an entire day and necessitated the participation of the project manager, at least two of the three lead engineers, several other project team engineers, and sometimes even a few of the nonprofessionals comprising the support staff. This administrative assignment had a noticeable impact on the project schedule. The heavy manhour consumption of the project review meetings reduced the manhours available for engineering and project coordination.

A related administrative assignment was the preparation of project review meeting minutes. ITT Rayonier required that lengthy and detailed minutes of these meetings be prepared by one of the lead engineers. CH_2M HILL's project manager would assign this responsibility on the basis of the topics covered at the meeting and would review the minutes prior to their distribution to the client. It was very important to take thorough and detailed notes during the meetings to facilitate preparation of the minutes. Writing the minutes of a review meeting typically consumed between one-half and one full day of a lead engineer's time. This activity was also a significant consumer of engineering and project coordination time.

Interaction With Other Consulting Firms

Two other consulting engineering firms also provided services to ITT Rayonier on the waste abatement project. A large geotechnical consulting firm prepared the soils investigation report on the site, developed preload design criteria, developed soils bearing capacities for the various structures, recommended foundation designs, and provided general geotechnical consulting services throughout the project. A small local consulting firm designed the solids handling portion of the treatment system and also provided the electrical design services for the entire project. It was necessary for me to interact regularly with these firms during the course of the design work on the project.

Interaction with the geotechnical consultant was necessary on matters related to the plantsite grading plan, specifically regarding surface runoff control and drainage considerations. It was also necessary to regularly exchange information and ask and answer questions in order to maintain consistency between the geotechnical findings and recommendations and the structural design of the various facilities. The coordination effort frequently involved seeking on behalf of CH_2M HILL's structural engineers interpretations and clarifications from the geotechnical firm on their recommended soils bearing capacities and foundation designs for the various structures. In turn, CH_2M HILL's preliminary foundation designs were presented to the geotechnical firm for review and comment. Considerable interaction was necessary to complete the unique structural design of the secondary clarifiers.

It was also necessary to interact with the smaller local consulting firm at regular intervals. As mentioned previously, I was assigned the responsibility of reviewing this firm's hydraulic design for the solids handling portion of the treatment system. Inter-firm communication was necessary during the review process and my findings were presented to both the client and the consultant at its conclusion.

Coordination of the electrical design was another aspect of inter-firm communication. This task partially consisted of providing the electrical consultant with information on the various power demands (mostly electrical motors) located throughout the treatment facility. It was also necessary to coordinate the electrical consultant's power feeder and conduit routing with CH_2M HILL's yard piping layout to avoid locational conflicts. Finally, it was my responsibility to provide the electrical consultant with answers to questions pertaining to the secondary clarifiers. Power requirements and instrumentation and control information were conveyed at their request.

Much of the required interaction was accomplished in meetings attended by representatives of CH_2M HILL, the client, and one or both of the other consulting firms. It was another of my administrative responsibilities to attend these meetings as requested by CH_2M HILL's project manager. As with the project review meetings, ITT Rayonier required lengthy and detailed meeting minutes and each of the consulting firms attending the meeting was asked to prepare them. Depending on the topics covered at the meeting, the responsibility for CH_2M HILL's meeting minutes was assumed by the project manager or assigned by him to one of the three lead engineers. Preparation of minutes for the portions of these meetings that I attended was another administrative assignment related to the interaction with other consulting firms.

Interaction With Equipment and Pipe Suppliers

Because of the size of the ITT Rayonier project, there were many equipment and pipe suppliers desiring to have their products incorporated into the treatment system design. The process of screening the vendors and their products was time-consuming and sometimes disruptive to the design effort.

CH_2M HILL prepared the specifications for most of the major equipment to be used in the treatment system -- secondary clarifier and sludge thickener mechanisms, pumps, blowers, valves, etc. Much of this work was completed in the predesign stage of the project prior to my assignment to the project team. However, the vendors' proposals for much of this equipment were not received until after final design had commenced. ITT Rayonier requested the design team's assistance in evaluating the proposals. Often the proposal evaluation process involved attending presentations by the vendors and discussing with them the technical aspects of their equipment design. Participation in this process was one of my administrative responsibilities during the internship.

My role in the preparation of the yard piping specifications led to another administrative assignment. The task of screening all interested pipe suppliers for the purpose of providing the client with an approved bidders list was assigned to me. As a result, ITT Rayonier's project manager directed many of the suppliers' questions regarding the specifications and the project in general to me. Also, most of the pipe suppliers wanted to make a presentation on their product. I was able to schedule many of these presentations so that they were given during project review meetings. However, some of the vendors dropped by the office without an appointment and requested the opportunity to make an impromptu presentation. It was my responsibility to accomodate them and thereby give all qualified vendors an opportunity to sell their product. This assignment led to some disruption of the design process.

A wealth of information pertinent to the design of the treatment system was gained by attending the presentations of the equipment and pipe suppliers. Another of my administrative responsibilities was to record and distribute this information. Individual technical memoranda were prepared for this purpose. The memoranda highlighted the presentations of the most reputable vendors and summarized important data from their product literature. The literature was attached, when appropriate, and the memoranda were circulated to affected members of the

CH_2M HILL design team, to the client, and to the other consultants. The technical memoranda served as an important vehicle for interaction with the CH_2M HILL staff.

Interaction With CH_2M HILL Staff

CH_2M HILL's project team consisted of the project manager, three lead engineers of which I was one, at least eleven other engineers of various technical fields on either a part-time or short duration full-time basis, and a support staff of technicians, drafting personnel, graphic artists, clerks, and secretaries on an "as needed" basis. The project manager was also a department manager and as such had to divide his time between his two responsibilities. Under these time constraints, he found it necessary to concentrate on project scheduling, progress reports, billings, and client contact. This type of project structure resulted in the lead engineers carrying the impetus for project team interaction.

The lead engineers coordinated the design efforts of the various technical disciplines and the contributions of the nonprofessional support staff working on the ITT Rayonier project. Considerable interaction with CH_2M HILL staff not working on the project was also required. This was a necessary part of the coordinator role served by each lead engineer for his areas of design responsibility. The areas in which I performed design coordination functions are discussed in the section DESIGN RESPONSIBILITIES. The coordination functions themselves included:

1. Keeping the various engineering department managers informed

of the project schedule and projected manpower requirements.

2. Working with the department managers to insure that the proper personnel were assigned to the project at the appropriate time.
3. Orienting the assigned personnel to the project and informing them of the goals, objectives, and standards for both the project and their individual tasks.
4. Scheduling drafting, graphic art work, clerical services, and typing and keeping these groups informed of the project schedule and projected manpower requirements.
5. Serving as liaison for all communications between the design team and the client and the other consulting firms working on the project.
6. Circulating minutes of project review meetings to the affected personnel.
7. Circulating to the affected personnel technical memoranda (and appropriate product literature) containing design information that was presented by major equipment and pipe suppliers.
8. Answering or obtaining answers from suppliers on design-related questions raised by the project team.
9. Assuring that the appropriate technical disciplines reviewed the various manufacturers' shop drawings.
10. Assuring that adequate in-house and client reviews of CH_2M HILL's design work were conducted.
11. Assuring that all review comments were addressed by the appropriate designers and that any necessary changes were accurately incorporated into the design drawings.

ANALYSIS OF CH_2M HILL'S ORGANIZATIONAL APPROACH TO THE INTERNSHIP PROJECT

There were certain non-technical problems associated with the internship project assignment. These problems primarily involved such areas as management, organizational behavior, and interpersonal relations among project team members. An analysis of these problems must focus on CH_2M HILL's organization approach to the project -- the project team. I had occasion to conduct such an analysis as part of the course requirements for Management 630 taught by advisory committee member Dr. Robert Albanese during spring semester 1981. The earlier written analysis was revised into a format appropriate for the Internship Report.

Most of the non-technical problems associated with the internship experience dealt with intragroup (project team) behavior. Figure 1 is A Framework for Group Behavior from Organizational Behavior and Performance by Szilagyi and Wallace. I have applied this framework and used the accompanying text as the basis for my analysis of the project team. All quotes in this section of the Internship report are from Szilagyi and Wallace.

Figure 1 presents some specific dimensions that influence group outcomes. These include individual dimensions, situational factors, group development, and structural factors. The internship experience could be analyzed in terms of all of these dimensions (and their subdimensions) in some detail. However, I have concentrated on those that I consider most significant.

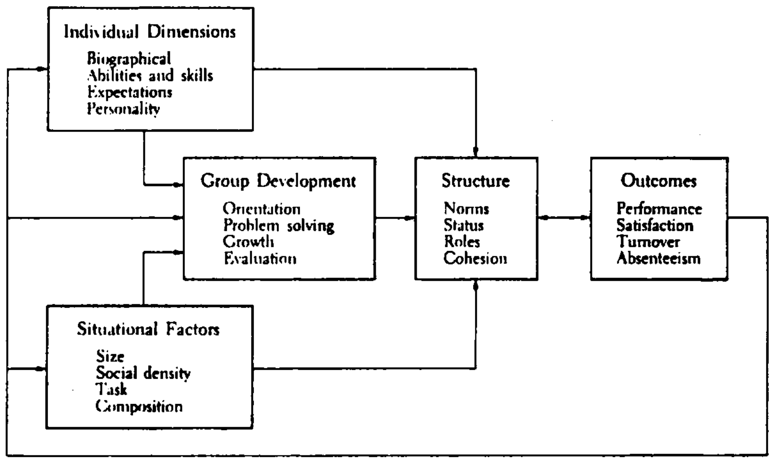

Figure 1. A Framework for Group Behavior

Classification of the Project Team

Various methods are used to classify the types of groups that exist in organizational settings. One of the methods of classification is by purpose of formation. The primary purpose for formation of the focal group (project team) was task accomplishment. This purpose leads to its classification as a task or project group. An additional distinction can be made by classifying groups as either formal or informal. The project team was a formal group, because its primary purpose was "facilitating, through member interaction, the attainment of [one of] the goals of the organization" -- successful and profitable completion of the project to the satisfaction of the client. "Informal groups, on the other hand, are groups that generally emerge naturally from the interaction of the members, and that may or may not have purposes that are related to or congruent with the goals of the orgainzation."

Individual Dimensions

In a focal group (group upon which the analysis is focused) of the size of the project team, the individual characteristics and behavioral patterns are numerous. However, those of the project manager and the three lead engineers probably had the most significant impact on the eventual performance of the group.

As indicated previously, the project manager's involvement in the group process was unusually low. He adopted what he termed a "management by crisis" style. In other words, he limited his involvement in the intragroup activities of the project team to resolution of true crisis situations. This management posture was due to role overload which occurs when the set of activities or behaviors in the group that an individual believes he or she should do exceeds what the individual can reasonably handle. The project manager was continuously involved in more projects and management activities than he or any other individual could handle.

This style was not consistent with the expectations of the other lead engineers and myself. We had anticipated a higher level of management participation and a more directive, authoritarian style. Although this style provided each of us with the opportunity to assume a management role in the project, it also resulted in our jobs being notably short of a core job characteristic dimension (those job dimensions that relate directly to the attainment of personal satisfaction from the job) -- feedback. The feedback on performance came primarily from the client.

Each of the lead engineers had high expectations for doing a competent job and performing well. To attempt to meet these personal expectations and to adjust for the unanticipated low level of project manager involvement in the group process, each lead engineer responded differently to his assignment. One sought additional work. He satisfied his high expectations with successes on several other smaller projects and feedback came more frequently due to the number of different projects. However, some of his satisfaction was diminished by the role overload he experienced. The second lead engineer enlisted a large support staff. He attempted to satisfy his expectations and prompt feedback by generating a large volume of work in his areas of responsibility through delegation. He adjusted very well to the low level of project manager involvement and actually enjoyed minimum management guidance and coordination. My response was to actively solicit the project manager's involvement and feedback in spite of his chosen management posture. When role overload developed, I often sought his input on the priorities of the various tasks in my areas of responsibility. I attemped to satisfy my high expectations with minimum delegation and by maintaining an appropriate level of work quality. Adjustment to the low level of project manager involvement was made by referring to the priority list for guidance and direction. However, my style was not well adapted to the project manager's style, because he was required to interact with me to establish task priorities. This was an exercise that he considered to be far less than a crisis.

Situational Factors

The organization creates certain conditions under which the group functions. These situational factors include the size of the group, social density, the type of task, and the composition of the group.

Information on group size and a description of group composition is presented in the section, The Intern's Position on the Project Team. From this information it can be concluded that the project team was a heterogeneous group. Research has indicated that this type of group (as opposed to a homogeneous group) can be expected to perform more effectively on tasks that are complex and require creative and innovative approaches to problems. Since complex tasks are the norm for engineering firms, CH_2M HILL and most others structure the organization around heterogeneous project teams.

The tasks encountered by the group during the internship experience were of the problem-solving type. Consistent with research findings, the group had a high action orientation and emphasized accomplishing the task correctly. Research has also shown that group leaders involved in these types of tasks are far more active and influence group behavior to a greater extent than leaders of other task groups. As mentioned previously, this was not the case during the internship.

The remaining situational factor is social density. This factor is significant in determining the degree of group member interaction. "Social density is defined as the number of group members within a certain walking distance (e.g., fifty feet) of each group member." Because of a temporary shortage of office space, one other lead engineer and I were located in offices at the opposite end of a large office building from the remainder of the project team. The impact of this situation was surprisingly significant. Group interaction was noticeably hampered, and complaints to management from all members of the project team steadily increased for several months. The frustration reached such a level that the client even began to comment on the situation. At that point a major office reorganization, affecting approximately 60 people, was ordered. The one positive outcome of this social density problem was a strong, professionally-supportive and socially-satisfying relationship between me and the other isolated lead engineer.

Group Development

In the development of the Figure 1 framework, it was assumed that task or project groups follow four stages of development: (1) orientation, (2) internal problem solving, (3) growth and productivity, and (4) evaluation and control. Orientation occurs when group members are brought together for the first time. "Problems arising from the orientation stage are confronted and attempts at solving these problems are made" during internal problem solving. "The growth and productivity stage is characterized by group activity directed almost totally to the accomplishment of the group's goals." The interpersonal relations within the group are marked by increasing cohesion, sharing of ideas, providing and getting feedback, and emerging openness. "The final stage, evaluation and control, focuses on the evaluation of individual and group performance."

A large portion of the focal group was comprised of part-time and short-duration full-time engineers and an as-needed support staff. Because of this characteristic of group composition, the stages of group development were not distinct and discrete. In general, the orientation stage was relatively short because most group members had worked together on previous projects. However, it was continuously re-occurring as the various short-term and as-needed members joined and left the group.

Internal problem solving was a significant effort for the group. This was primarily due to the adjustment that had to be made to the project manager's style and the unusually high level of participation by the client in the design process. Nonetheless, the group dealt with its major problems (both intra- and intergroup) in a reasonably expeditious manner. Since a good portion of the internal problem solving stage is consumed with the problems arising in the orientation stage, problem solving seemed to continuously reoccur as new short-term members received their orientation into the group.

The growth and productivity stage was the longest of the development stages experienced by the group. This was as one might expect for a successful service-oriented group and organization. Group cohesion increased satisfactorily. Most importantly, there was a dramatic increase in the sharing of ideas for task accomplishment which proved to be the key to the group's success in achieving its goals. Feedback and openness never really emerged to a satisfactory level.

The evaluation and control stage did not seem to discretely present itself, apparently because of the changing group structure and the inadequacy of various feedback mechanisms.

Structural Dimensions

"Group structure can be viewed as the framework or pattern of relationships among members that assists the group in working toward its goal." The structural dimensions of significance in terms of their effect on the focal group's performance were the roles adopted by the project manager and the lead engineers. As indicated previously, role conflict (multiple demands and directions creating uncertainty in the individual's mind concerning what should be done, when, or for whom) and role overload influenced the project manager to limit his activity in the group. He consequently limited the extent of his influence on group behavior. The group anticipated a more active role and when it did not come to pass, some degree of role ambiguity resulted. "Role ambiguity is the lack of clarity regarding job duties, authority and responsibility that the individual perceives in his or her role."

There are two basic roles in groups: task-related roles and maintenance-related roles. Task-related roles place emphasis on getting the job done by such actions as organizing the work, establishing communications networks and evaluating work group performance. Maintenance-related roles are those roles (behaviors) an individual engages in to sustain the group, such as trying to draw all members into the group or trying to solve internal problems. The latter role is more people-oriented and emphasizes delegation of responsibility and a concern for the welfare, needs, advancement, and personal growth of the group members. It is possible for group members to assume both task-related and maintenance-related roles, varying from a high to a low orientation on each role.

When the project manager did choose to intervene in group processes, his role was almost exclusively task-related. One of the lead engineers also assumed a task-related role and to a similar (to the project manager) degree. The second lead engineer played primarily a maintenance-related role. He expended a great deal of effort trying to involve many group members in decisions, provide feedback on group performance, assign meaningful and significant tasks, and solve internal group problems. My perception is that I assumed a slightly more maintenance-related role in the group and a lower task-related orientation.

Outcomes

From the macro-standpoint, group outcomes were favorable. The ITT Rayonier project was completed on time and within the budget. The client was pleased with the performance of the design team and subsequently awarded CH_2M HILL another similar contract that was three to four times larger and much more technically complicated. Along with the award of the new contract, the client's project manager strongly suggested that two of the three lead engineers function as project manager and assistant project manager on the upcoming project. CH_2M HILL made considerable profit on the project and, as noted previously, received honorable mention in an engineering excellence competition. In general, many of the organization's objectives were met.

In the micro-view, group outcomes were a mixture of favorable and unfavorable. Although group performance was more than satisfactory if measured by the macro-outcomes above, group satisfaction varied a great deal. Some group members were well satisfied with the success of a major project made difficult by several factors beyond their control. Others were less satisfied because they experienced to varying degrees unfulfilled expectations, role overload, and role ambiguity.

Turnover in the strictest sense did not occur. There were no employees that left CH_2M HILL as a result of their experiences in the focal group. However, there were some group members that requested reassignment during the project. There were only minor problems with absenteeism and most instances occurred amongst the nonprofessional support staff.

SUMMARY

The purpose of this report was to establish that the objectives of the Doctor of Engineering internship had been met. It recounts the design activities and administrative assignments involved in meeting the project assignment objectives established by the intern and approved by the internship supervisor and the advisory committee.

Design responsibilities on the ITT Rayonier project included several general tasks that essentially affected the entire waste abatement facility. The hydraulic design of the wastewater treatment portion of the facility was completed. All of the major yard piping (larger than 12-inch diameter) and most of the general yard piping (12-inch diameter and under) were designed. Specifications for the major yard piping and general yard piping were written. The plantsite grading plan was initiated and coordinated until its completion.

Other design responsibilities dealt with individual wastewater treatment units. The civil/mechanical engineering aspects of the secondary clarifier design were completed and the structural design was coordinated until its completion. Modifications to the existing primary clarifier were designed. The design of piping in the aeration basin, including diffusers for the influent wastewater and return activated sludge, was completed. The concept for an aeration basin effluent structure was developed and the mechanical aspects were designed. The intern was responsible for preparation, coordination, and/or quality control on many of the project design drawings.

Several administrative assignments were also undertaken during the internship project. As requested by the project manager, project

review meetings and meetings with other consulting firms working on the project were attended. Lengthy and detailed minutes of these meetings were prepared and distributed in-house and to the client. At the client's request, presentations by major equipment suppliers and pipe manufacturers were attended and their products evaluated. The pertinent design information presented by the suppliers was summarized and circulated to the project team. The design efforts of the various technical disciplines and the contributions of the nonprofessional support in the intern's assigned areas of design responsibility were coordinated.

The internship experience resulted in an awareness of CH_2M HILL's organizational approach to problems and projects. Subsequent to the internship, an analysis of this approach focusing on intragroup behavior within the project team was conducted. The analysis is presented in this report.

The intern's project assignment allowed for demonstration of the ability to apply knowledge and technical training so as to make an identifiable contribution in an area of practical concern to CH_2M HILL. The internship also provided the opportunity to function in a non-academic environment and become aware of the organizational approach to problems. Thus, the two basic objectives of the Doctor of Engineering internship were met.

The internship was a valuable educational experience and provided a unique opportunity to continue a professional career and, at the same time, make progress in one's academic pursuits. The ITT Rayonier project was not a picture of perfection and no engineering project is.

However, from the standpoint of an internship experience, it was virtually ideal. There were no areas apparent to the intern in which the internship could have been improved.

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APPENDIX A

Statement of Purpose in Seeking the Doctor of Engineering Degree

STATEMENT OF PURPOSE IN SEEKING THE DOCTOR OF ENGINEERING DEGREE

Through my experience with a large environmental engineering consulting firm, I have become aware of a weakness in many of today's young engineers. For the most part we are adequately trained technically but lack educational background and understanding in the area aptly termed "professional development" in your program. Lack of instruction in the legal, economical, social, political, managerial, and communicative aspects of engineering often leads to less than optimum utilization of technical training and makes adjustment to managerial responsibilities difficult for most of us and impossible for some. I view the Doctor of Engineering program as an excellent means by which to fill this void in my educational background.

Certainly I consider adequate the technical training in environmental engineering which I am now receiving at Stanford University. However, acceptance to the Doctor of Engineering program will provide the opportunity for additional course work in this area. When dealing with the complexities of pollution control problems, additional education can only increase my effectiveness.

Another aspect of your program which is very important to me is the emphasis on practical application of the student's educational background during the internship period. Many graduating engineers find themselves severely handicapped in the performance of their job by lack of practical experience.

Finally, it is my conviction that engineering students who are desirous of obtaining advanced degrees should have the opportunity to study toward those degrees without being forced to dedicate an academic year or more to research. It is my ambition to be a practicing engineer at the doctoral level and I have no interest in research at this point. The substitution of an invaluable year of practical experience for the usual dissertation research is ideally suited for my situation. I am confident that my acceptance to this new and innovative program will enhance my chances of eventually functioning at the "highest levels of the engineering profession."

William J. Winter
March 1975

APPENDIX B

Excerpts from Monthly Internship Activities Reports

July and August 1975

1. After reviewing a considerable amount of project background information, I prepared a layout of the plantsite to show general orientation of the treatment units and the connecting piping.

2. Evaluated three alternative piping systems for splitting flow from the aeration basin to the secondary clarifiers. The primary considerations were economics and hydraulics.

3. Conceptualized and prepared sketches of an effluent structure in the aeration basin to split flow equally to three 150-foot-diameter secondary clarifiers. These sketches were for inhouse and client review.

4. The project manager, another project engineer, and I met with the client's engineers on 31 July 1975. The purposes for my involvement in the meeting were to become acquainted with the client's representatives and to solicit their preliminary preferences on various details affecting the design of the secondary clarifiers.

5. Prepared minutes of the 31 July meeting for distribution to the client and for future reference inhouse.

6. Prepared an area plan showing the relative locations of the existing 210-foot-diameter primary clarifier and the three secondary clarifiers.

7. Added to the above-mentioned area plan my preliminary design of the yard piping in the vicinity of the clarifiers for inhouse and client review.

8. Began design work on the secondary clarifiers. Using previous CH_2M HILL plans as a guide, I developed a preliminary list of the plans, sections, and details that should be shown on the final sheets and reviewed this list with the project manager.

9. Using the above-mentioned list as a guide for detailed design, I prepared the following worksheet drawings:

   A. A composite section of the secondary clarifier tank, mechanism, and piping.

   B. Plans showing the orientation of the mechanism support pier and the center sludge hopper.

   C. A typical wall section showing footing, launder, weir, and top of wall elevations and wall thickness and launder width.

D. A plan and sections of the outlet box through which the clarified wastewater passes from the launder to the effluent piping.

E. A plan, section, and detail of the stairways required for access to the clarifier walkway bridges.

F. A detail of the underdrain system necessary to eliminate hydrostatic uplifting pressures when dewatering the clarifier tanks.

G. A detail showing scum piping through the clarifier walls.

H. A detail of the clarifier scum baffle and weir.

10. Accompanied another design engineer to the office of the client for a meeting on 11 August 1975. The purposes of my involvement were to provide support for the other engineer, to meet additional representatives of the client, and to observe the treatment plant-site firsthand.

11. Prepared minutes of the 11 August meeting for distribution to the client and for future reference inhouse.

12. Continued work on yard piping and initiated an economic analysis of several alternative piping materials with the CH_2M HILL estimating department.

13. Participated in the development of nomenclature and abbreviations to be used on the design sheets in reference to the pipeline contents and piping material.

14. Familiarized myself with a CH_2M HILL computer program for hydraulic analysis of various elements encountered in typical wastewater treatment facilities. Made necessary hydraulics calculations to run this program and give preliminary check of plant hydraulics.

15. On 25 August 1975, I discussed engineering careers with a patient from the University of Washington Hospital. The young man had suffered a spinal injury in an automobile accident and had lost some dexterity and grip strength in his hands and some mobility in his legs. I was asked to discuss with him some of the things engineers do.

16. On 26 August, representatives of the client and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

A. Presentation of preliminary clarifier and yard piping drawings.

B. Discussion of alternatives regarding exposed or buried piping.

C. Presentation and discussing of preliminary findings of the economic analysis of yard piping materials.

D. Discussion of location and orientation of clarifier stairways and walkways.

E. Discussion of clarifier launder cleaning and maintenance.

F. Discussion of scum collection and piping.

17. Prepared minutes of the 26 August meeting for distribution to the client and for future reference inhouse.

<u>September 1975</u>

1. Prepared preliminary plan and sections of the secondary clarifier mechanism support and sludge hopper. (These will serve as structural drawings. A structural engineer will review them and add the necessary reinforcing steel and structural details.)

2. Initiated and coordinated economic analyses of additional yard piping material alternatives by CH_2M HILL's estimating department.

3. At the direction of the client's representatives, revised yard piping plans for future review.

4. On 10 September 1975, representatives of the client and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

   A. Review of changes made in yard piping layout since the previous meeting.

   B. Presentation of a preliminary grading plan.

   C. Discussion of a format for showing the profiles of all major pipelines.

   D. Review of changes made in secondary clarifier drawings since the previous meeting and discussion of client's recommendations for additional changes.

   E. Presentation and discussion of final results of the economic analysis of yard piping materials.

5. Prepared minutes of the 10 September meeting for distribution to the client and for future reference inhouse.

6. Prepared preliminary profiles of major yard piping showing existing and final grade and existing piping in the area around the clarifiers.

7. Reviewed Hydraulic Institute standards for future reference in return sludge pump station design.

8. Incorporated client's recommended changes and checked drafting on all secondary clarifier drawing.

9. On 25 September 1975, representatives of the client and CH_2M HILL met to discuss the progress of design efforts and to receive a presentation by a high-speed aerator vendor. My involvement in the meeting included:

   A. Discussion of the secondary clarifiers foundations, underdrain system, and mechanism support pier.

   B. Further discussion of the results of the economic analysis of the yard piping materials alternatives.

   C. Discussion of the hydraulic profile through the treatment plant.

   D. Discussion of concrete encasement of piping under the clarifiers and proposed methods of joining different types of piping.

   E. Presentation and discussion of revised yard piping drawings and preliminary profiles of major yard piping.

10. Prepared minutes of the 25 September meeting for distribution to the client and for future reference inhouse.

11. Began revisions of yard piping profiles as per client's review comments.

<u>October 1975</u>

1. On 1 and 2 October 1975, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts and to receive presentations by a high-speed aerator supplier and sludge thickener suppliers. My involvement in the meeting included:

   A. Discussion of a cost comparison between stainless steel and carbon steel piping under the secondary clarifiers.

   B. Discussion of flow characteristics of various yard piping material alternatives.

   D. Discussion of scum piping.

2. Prepared minutes of the 1 and 2 October meeting for distribution to the client and for future reference inhouse.

3. Completed revisions of yard piping profiles as per clients review comments.

4. Revised plant hydraulics calculations to reflect changes in yard piping layout and profiles. Used this information to run CH_2M HILL computer program which defined the hydraulic profile through the treatment plant.

5. At the client's request, investigated the hydraulics implications of raising the secondary clarifiers 2 to 2½ feet in elevation.

6. Investigated and quantified the effect of different yard piping materials on the hydraulic profile through the treatment plant.

7. Combined 5 and 6 above into a number of alternatives to present to the client.

8. Ran CH_2M HILL hydraulics computer program to determine hydraulic profile through treatment plant at average and peak flows (27 and 32 MGD, respectively).

9. Prepared, in worksheet form, a schematic of the treatment plant showing the above-mentioned hydraulic profiles through each treatment unit.

10. Made some modifications to the secondary clarifier center support structures as a result of changing piping orientation.

11. On 15 October 1975, representatives of CH_2M HILL and RMP Co., another consulting firm working on ITT Rayonier's waste abatement project, met to coordinate engineering efforts. My involvement in the meeting included:

    A. Discussion of facilities affecting the yard piping design.

    B. Discussion of the design drawing numbering system.

12. Worked with another project engineer to prepare revised project schedule.

13. Verified preliminary sizing of pipes between the aeration basin and the secondary clarifiers.

14. Another project engineer and I met with the project manager to review the project status, schedule, staffing, and budget.

15. Made another revision of treatment plant hydraulics calculations based on most preferable of alternatives mentioned in 7.

16. Modified hydraulic profile worksheet to reflect above-mentioned revision.

17. On 21 October 1975, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

    A. Presentation and discussion of the hydraulic profile worksheet.

    B. Discussion of the effects of various yard piping materials alternatives on the treatment plant hydraulics.

    C. Discussion of the laying lengths of various types of piping and how this affects construction.

    D. Presentation and discussion of the yard piping profiles in worksheet form.

    E. Presentation and discussion of the several drawings on the secondary clarifiers.

    F. Discussion of the interface between the engineering efforts of the various consulting firms working on the ITT Rayonier project.

    G. Discussion of the secondary clarifier underdrain systems and effluent outlet boxes.

18. Prepared sketches of alternative effluent outlet structures for the secondary clarifiers. These are to be reviewed with CH_2M HILL structural department for structural implications and ease of construction when structural design of clarifier tanks begins.

19. Finalized hydraulic profile worksheet for drafting.

20. On 29 October 1975, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts and to receive a presentation by Stauffer Chemical Company on phosphoric acid handling. My involvement in the meeting included:

    A. Discussion of the influent and return activated sludge piping in the aeration basin.

    B. Discussion of the hydraulic profile.

    C. Discussion of alternatives for connections between FRP (fiberglass) or TECHITE pipe and welded steel pipe.

    D. Discussion of the location of all piping from the pulpmill to the treatment system.

<u>November 1975</u>

1. Checked and updated hydraulics calculations for all pumping systems included in the project.

2. Revised and updated input to CH_2M HILL hydraulics computer program per review by another project engineer.

3. Re-ran hydraulics computer program based on input developed in no. 2 to determine new hydraulic profile through the treatment plant.

4. Developed preliminary layout of influent and return activated sludge piping in the aeration basin.

5. Prepared minutes of the 29 October 1975 meeting with ITT Rayonier for distribution to the client and for future reference inhouse.

6. Prepared minutes of the 21 October 1975 meeting with ITT Rayonier for distribution to the client and for future reference inhouse.

7. Prepared minutes of the 15 October 1975 meeting with RMP Co., another consulting firm working on ITT Rayonier's waste abatement project, for distribution to the client and for future reference inhouse.

8. On 13 November 1975, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

   A. Discussion of plant hydraulics problems associated with an existing control valve on the existing outfall. Several alternative solutions were presented.

   B. Discussion of yard piping.

   C. Discussion of the need for and location of a treatment system bypass.

   D. Discussion of project schedule and timing for the beginning of preparation of yard piping specifications.

   E. Discussion of KwiKey (lock-joint) fiberglass pipe as an alternative for small yard piping.

   F. Presentation of revised pump hydraulics calculations.

9. Prepared minutes of the 15 November meeting for distribution to the client and for future reference inhouse.

10. Assisted with the preparation of monthly progress of engineering reports for September and October 1975. These reports were submitted to the client.

11. With another project engineer, sized all process pipelines included in the treatment system.

12. Completed first draft of a specification for fiberglass reinforced plastic (FRP) or reinforced plastic mortar (RPM) pipe. These two materials were selected by the client as alternatives for major (12-inch diameter and larger) yard piping. The specification package will be distributed to FRP and RPM pipe suppliers for price quotes.

13. Prepared data for and ran CH_2M HILL diffuser computer program to develop preliminary design of influent and return activated sludge diffusers in the aeration basin.

December 1975

1. Completed preliminary sizing of the influent and return-activated sludge diffusers in the aeration basin using CH_2M HILL diffuser computer program.

2. On 2 December 1975, representatives of CH_2M HILL, ITT Rayonier, and RMP Co., another consulting firm working on ITT Rayonier's waste abatement project, met to discuss and coordinate the layout of yard piping and electrical conduit. My involvement in the meeting included:

   A. Discussion of the possibility of moving a transformer pad which was preliminarily located directly over a 30-inch secondary clarifier effluent line.

   B. Presentation and discussion of the Secondary Clarifier Area Plan, Yard Piping Profiles (3 sheets), CH_2M HILL standard mechanical legend, and the General Piping Plan.

   C. Discussion of the design drawing numbering system and coordination of same with RMP Co.

3. Calculated headloss imposed by relocating the 30-inch secondary clarifier effluent line rather than relocating the transformer pad as discussed in 2A.

4. Computed headloss in the aeration basin influent diffuser using CH_2M HILL diffuser computer program.

5. Computed the head saved by removing the V-port from the existing outfall control valve. The outfall control valve is presently used to maintain a water level in the primary clarifier launders that will minimize free fall and consequently foam generation.

6. Input data from 4 and 5 into CH_2M HILL hydraulics computer program to determine revised hydraulic profile through new and existing portions of the treatment system.

7. Assisted with the preparation of monthly progress engineering report for November 1975 to submit to the client.

8. Reviewed completed portion of mechanical design of secondary clarifiers with structural engineer to initiate his structural design efforts.

9. Added preliminary influent and return-activated sludge diffuser layouts to worksheet of the aeration basin area plan.

10. Made other revisions and corrections to the aeration basin area plan and prepared it for drafting.

11. On 10 December 1975, representatives of CH_2M HILL and Shannon & Wilson, a geotechnical consulting firm working on ITT Rayonier's waste abatement project, met to discuss soils-related problems affecting the design of the blower building and the secondary clarifiers. My involvement in the meeting included:

    A. Discussion of the hydraulics and process problems that are likely to be encountered should the predicted excessive settlement occur.

    B. Discussion of the effects of excessive and differential settlement on the secondary clarifier mechanism.

    C. Discussion of the possibility of building some adjustability into the clarifier mechanism so that some of the problems caused by settlement could be corrected by field adjustment.

12. On 11 December 1975, representatives of CH_2M HILL and ITT Rayonier met to discuss the progress of design efforts and especially soils-related problems affecting the design of the blower building and the secondary clarifiers. My involvement in the meeting included:

    A. Presentation of the aeration basin plan.

    B. Discussion of types of pipe supports and maximum spacing of the supports for piping in the aeration basin.

    C. Presentation of the preliminary design for the influent and return-activated sludge diffusers in the aeration basin. Pipe and port size, port orientation, and port spacing were presented.

    D. Discussion of treatment system startup procedure.

    E. Presentation of a worksheet on the aeration basin effluent structure and discussion of the following specifics:

        1. Materials of construction for the three 36" x 72" stop gates.

        2. Materials of construction for the 36-inch diameter inserts (wall pipes) that connect to piping to the secondary clarifiers.

3. Handrails and handrail supports.

4. Grating over open areas.

F. Discussion of small yard piping.

G. Discussion of potential adverse effects which excessive settlement of the secondary clarifier tanks may have on treatment efficiency, hydraulics, and the clarifier mechanisms.

H. Discussion of possible secondary clarifier mechanism modifications to achieve maximum adjustability. Field adjustments could be used to correct for the settlement problems.

I. Discussion of the secondary clarifiers underdrain system and the possible addition of footing drains.

13. Prepared minutes of 10 December meeting with Shannon & Wilson for distribution to the client and for future reference inhouse.

14. Met with representative of Owens-Corning to receive a presentation on that company's FRP pipe.

15. With another project engineer, prepared a technical memorandum on phosphoric acid handling from the information presented by Stauffer Chemical representatives during the meeting of 29 October 1975. This memorandum will be distributed to the industrial processes personnel within CH_2M HILL.

16. Met with representative of Quaker Chemical Corporation to discuss defoamer characteristics, handling, and storage.

17. Revised first draft and prepared second draft of yard piping specifications for fiberglass-reinforced plastic (FRP) and reinforced-plastic mortar (RPM) pipe.

18. Assisted with the preparation of reports to the client on design drawing status and engineering status.

19. Submitted list of FRP and RPM pipe manufacturers to the client to use a guide for soliciting price quotes on yard piping.

20. Checked adequacy of width and depth of secondary clarifier launders as previously designed.

21. Prepared sketch of modifications which must be made to the existing primary clarifier when the new secondary treatment system becomes operational.

22. Assisted with the preparation of a complete design drawing list for the project.

23. Began the preparation of a piping materials specification for all services in the treatment system.

January 1976

1. Re-ran CH_2M HILL hydraulics computer program to revise the hydraulic profile through the treatment plant.

2. Revised and updated the general piping plan.

3. Continued work on modifications which must be made to the existing primary claifier when the new secondary treatment system becomes operational.

4. Completed first draft of piping materials specifications for all piping services in the treatment system.

5. Assisted with design of yard piping around the return activated sludge pump station.

6. Coordinated efforts of other engineers on the secondary clarifiers mechanical and structural design.

7. Prepared a profile drawing of the influent and return activated sludge lines to the aeration basin.

8. Assisted with the preparation of monthly design drawing and engineering status reports for December 1975. The reports were submitted to the client.

9. Assisted another project engineer with the development of a coordinate and stationing schedule for locating the bends, special fittings, and connections associated with all yard piping.

10. On 7 January 1976, representatives of CH_2M HILL and ITT Rayonier met to discuss the progress of design efforts. My involvement in the meeting included:

    A. Discussion of the preliminary work on the piping materials specifications and the work remaining to complete them.

    B. Discussion of the stop gates to be used in the aeration basin effluent structure.

    C. Discussion of review comments on the yard piping specification for fiberglass reinforced plastic (FRP) and reinforced plastic mortar (RPM) pipe.

    D. Discussion of the detail drawings which will be necessary to show inserts (wall pipes), piping under the secondary clarifiers, and a special fabricated metal transition piece for the existing primary clarifier.

E. Explanation of the coordinate and stationing system which will be used to locate and design all of the yard piping.

F. Presentation of sketches on, and discussion of modifications which must be made to the existing primary clarifier when the new secondary treatment system becomes operational.

G. Discussion of the scheduling of the modifications, in F above, as required to minimize down time.

11. Relocated the return activated sludge line and added several air distribution pipelines to the aeration basin area plan per client's request.

12. Assisted with the preparation of minutes of the 8 January meeting for distribution to the client and for future reference inhouse.

13. Again, re-ran CH_2M HILL hydraulics computer program to revise the hydraulic profile through the treatment plant.

14. Completed the second draft of the piping materials specification for all piping services in the treatment system.

15. Contacted Dorr-Oliver (secondary clarifier mechanism supplier) representative and requested that he attend our next meeting with ITT Rayonier. Requested that he be prepared to discuss the adverse effects of differential settlement of the clarifier tanks on the mechanism and how to minimize these effects.

16. Checked and finalized for drafting a work sheet of the gravity thickener-aerobic digester area plan which another engineer had prepared.

17. Began preparation of yard piping description sheets. The description sheets serve as attachments to the yard piping specification for FRP and RPM pipe which I prepared earlier. They contain information on the approximate length of pipe, the attitude of the pipeline (straight, sloping, level, number of bends, etc.), the fittings and specials required, the characteristics of the liquid conveyed, the conditions of installation (depth of backfill, proximity of roadways, need for joint harnesses, etc.), and the design drawings to use for reference.

18. On 15 January 1976, representatives of CH_2M HILL, ITT Rayonier, and Shannon & Wilson (a geotechnical consulting firm working on ITT Rayonier's waste abatement project) met to review design progress and particularly to discuss the soils loading criteria to be used in the structural design of the secondary clarifiers. My involvement in the meeting included:

A. Discussion of the function and requirements of the secondary clarifiers underdrain system and selection of the piping material to be used.

B. Discussion of material and joint type to be used for process piping under the secondary clarifiers.

C. Presentation and discussion of the secondary clarifier scum piping design.

D. Discussion of the stairway and landing system which will be used to provide access to the secondary clarifier bridge walkways.

E. Presentation and discussion of the primary yard piping description sheets as discussed in 17.

F. Discussion of the nomenclature to be used for the various facilities in the treatment system.

G. Presentation of the General Piping Plan.

H. Discussion of a grading plan for the treatment plant site.

I. Presentation of the Yard Piping Profiles.

J. Presentation of the Aeration Basin Area Plan and discussion of the thrust blocking requirements for the piping in the aeration basin.

19. Redesigned the thickener supernatant pipeline.

20. Assisted with the preparation of minutes of the 15 January meeting with ITT Rayonier and Shannon & Wilson for distribution to the client and for future reference inhouse.

21. Met with representatives of Techite RPM pipe to discuss the yard piping design and project timing.

22. On 20 January 1976, representatives of CH_2M HILL, ITT Rayonier, Shannon & Wilson, and Dorr-Oliver met to review design progress and particularly to discuss the adverse effects of differential settlement of the clarifier tanks on the clarifier mechanism and how to minimize these effects. My involvement in the meeting included:

A. Questioning the Dorr-Oliver representative about building adjustability into the mechanism such that field adjustments could be used to compensate for settlement of the clarifier tanks.

B. Discussion of the effects of secondary clarifier settlement on the hydraulics of the treatment system.

C. Discussion of potential problems with rising sludge that may result from differential settlement across the clarifier tanks. Differential settlement may cause low spots in the clarifier floor that the rake arms of the mechanism do not reach. Sludge buildups followed by decomposition, gas formation, and rising sludge could result and adversely affect effluent quality.

D. Discussion of materials alternatives for scum piping.

E. Discussion of timing for completion of a preliminary grading plan.

23. Met with representatives of Owen-Corning FRP Pipe and Diamond Shamrock Resins to discuss yard piping requirements and project timing.

24. Assisted another project engineer with the design of all minor (12-inch diameter and smaller) yard piping.

25. Assisted with the preparation of minutes of the 20 January meeting with ITT Rayonier, Shannon & Wilson, and Dorr-Oliver for distribution to the client and for future reference in-house.

26. Again, re-ran CH_2M HILL hydraulics computer program as necessary to determine the required pipe inverts at the aeration basin effluent structure.

27. Obtained necessary prices from vendors and prepared a cost comparison of FRP versus cast iron as piping materials for scum piping. Cast iron was selected.

28. Finalized the location and determined final coordinates of the aeration basin effluent structure.

29. Added plant site roadways and a security fence to the General Piping Plan.

30 . Added roadways to, and revised the Thickener-Digester Area Plan.

31. Initiated the structural design of concrete pipe supports for the piping in the aeration basin and the design of the fabricated metal work necessary to modify the existing primary clarifier.

32. Initiated the preparation of detail drawings on the process piping under the secondary clarifiers.

<u>February 1976</u>

1. Initiated and coordinated the preparation of a treatment plantsite

grading plan by a CH_2M HILL geotechnical technician.

2. Coordinated drafting of the site grading plan.

3. Coordinated drafting of detail drawings on the process piping under the secondary clarifiers.

4. Revised the yard piping profile sheets.

5. Completed yard piping description sheets. The description sheets serve as attachments to the yard piping specification for fiberglass reinforced plastic (FRP) and reinforced plastic mortar (RPM) pipe which I prepared earlier. They contain information on the approximate length of pipe, the attitude of the pipeline (straight, sloping, level, number of bends, etc.), the fittings and specials required, the characteristics of the liquid conveyed, the conditions of installation (depth of backfill, proximity of roadways, need for joint harnesses, etc.), and the design drawings to use for reference.

6. Coordinated the finalization of the Thickener-Digester Area Plan, the Secondary Clarifiers Area Plan, and the Aeration Basin Area Plan.

7. On 6 February 1976, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

   A. Discussion of the yard piping bid package which was to be distributed for price quotes to FRP and RPM pipe suppliers. The package included the yard piping specification and description sheets and a legend sheet, a general piping plan, three area plans, and the yard piping profile drawings.

   B. Discussion of the need to detail the connections between the yard piping and inserts (wall pipes) at the various structures on the plantsite.

   C. Discussion of ITT Rayonier's requirements for pressure testing of pipelines after construction.

   D. Discussion of the status of the site grading plan.

   E. Presentation of preliminary worksheets on the modifications which must be made to the existing primary clarifier when the new secondary treatment system becomes operational.

   F. Presentation of sketches on the concrete saddles to be used to support process piping in the aeration basin.

   G. Discussion of some of the structural details of the secondary clarifiers.

H. Discussion of the status of the detail drawings on the process piping under the secondary clarifiers.

8. Initiated and coordinated the preparation of detail drawings by another engineer on the fabricated metal piping associated with the secondary clarifiers.

9. Assisted with the preparation of minutes of the 6 February meeting for distribution to the client and for future reference in-house.

10. Revised, per review comments by ITT Rayonier, and prepared for drafting the worksheets showing the modifications which must be made to the existing primary clarifier.

11. Prepared detail drawings of the fabricated metal work associated with the primary clarifier modifications in #10.

12. Reviewed a proposal by Dorr-Oliver (the secondary clarifier mechanism supplier) which presented detailed descriptions of adjustability features which could be built into the mechanisms. These features could provide the capability to compensate for settlement of the clarifier tanks by upward field adjustments to the mechanism.

13. On 11 February 1976, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

    A. Presentation of the detail drawings on the process piping under the secondary clarifiers.

    B. Presentation and discussion of the detail drawings on the fabricated metal piping associated with the secondary clarifiers.

    C. Presentation of my comments on the Dorr-Oliver proposal discussed in #12.

    D. Discussion of concepts for design of a junction structure over the existing outfall line where the new secondary clarifier effluent lines will connect to the outfall.

    E. Discussion of the status of the aeration basin effluent structure design.

14. Assisted with the preparation of minutes of the 11 February meeting for distribution to the client and for future reference in-house.

15. Revised the legend sheet.

16. Added symbols for flanges and flanged coupling adaptors to the yard piping profile drawings in appropriate locations. The couplings will connect the flanged FRP or RPM yard piping to plan end inserts (wall pipes) at the various structures.

17. Assisted with the preparation of monthly design drawing and engineering status reports for January 1976. The reports were submitted to the client.

18. Prepared specifications for cast iron pipe and fittings, including push-on joint type, flanged joint type, and wall pipe, and submitted them to the client for use in purchasing the scum piping materials.

19. Began preparation of detail drawings of the connections discussed in #16. Included with each detail is a table indicating pipeline name, pipe size, pipe stations, coordinates, invert elevation, ground elevation, and pipe slope at the connection point.

20. Continued to coordinate efforts of other engineers on the secondary clarifier mechanical and structural design.

21. Coordinated the efforts of another engineer on the mechanical design of the aeration basin effluent structure.

22. Computed forces due to thrust at several critical locations in the yard piping. Structural engineers will use these forces in the design of concrete thrust blocking when it is necessary.

23. Again revised, per review comments by ITT Rayonier, the design drawings on modifications to the existing primary clarifier and detail drawings on the associated fabricated metal work.

<u>March 1976</u>

1. Completed detail drawings of the connections between the flanged yard piping and the plain end stainless steel inserts (wall pipes) at the various structures. Included with each detail is a table indicating pipeline name, pipe size, pipe station, coordinates, invert elevation, ground elevation, and pipe slope at the connection point.

2. Made minor modifications to the yard piping profiles.

3. Revised, per review comments by ITT Rayonier, design drawings on modifications which must be made to the existing primary clarifier when the new secondary treatment system becomes operational.

4. Revised, per review comments by ITT Rayonier, detail drawings of the fabricated metal work associated with the modifications discussed in #3.

5. Finalized and issued for construction the following design drawings: General Piping Plan, Thickener-Digester Area Plan, Secondary Clarifier Area Plan, Aeration Basin Area Plan, and Yard Piping Profiles -- 1 through 4.

6. Made miscellaneous revisions to the secondary clarifier mechanical drawings per review comments by ITT Rayonier.

7. Reviewed final yard piping specifications and description sheets and the drawings mentioned in #5, with John Lee, the project manager.

8. Answered questions about project timing and bidding procedures for the local representative of Techite RPM pipe.

9. On 3 March 1976, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

   A. Discussion of the preliminary site grading plan.

   B. Discussion of washdown water pump and piping locations and hose bibbs locations and how to best show them on the plans.

   C. Discussion of final changes that were made to yard piping specifications and description sheets and yard piping profiles per review by John Lee as discussed in #7.

   D. Review of mathematical and technical accuracy of the two low bids received by ITT Rayonier from suppliers of fiberglass reinforced plastic (FRP) and reinforced plastic mortar (RPM) yard piping.

   E. Presentation of worksheets on the treatment system bypass line and on the outfall junction structure (structure at which the new secondary clarifier effluent lines connect with existing outfall line).

10. Made final revisions to yard piping specifications and description sheets and yard piping profiles for ITT Rayonier's use in preparing a purchase order for the pipe. Ershigs, Inc. of Bellingham, Washington, an FRP pipe manufacturer, was selected as the yard piping supplier.

11. Prepared a cover letter identifying the final revisions discussed in #10 for ITT Rayonier's use in preparing the purchase order.

12. Assisted with the preparation of minutes of the 3 March meeting for distribution to the client and for future reference in-house.

13. Assisted with the preparation of monthly design drawing and engineering status reports for February 1976. The reports were submitted to the client.

14. Reviewed, revised, and prepared for drafting a mechanical design worksheet of the aeration basin effluent structure which was developed by another project engineer.

15. Developed a new design drawing showing miscellaneous mechanical details of the secondary clarifiers.

16. Reviewed shop drawings submitted by the supplier of the fabricated metal work associated with the secondary clarifiers.

17. Revised the design of the waste activated sludge piping near the north secondary clarifier.

18. On 16 March 1976, representatives of CH_2M HILL, ITT Rayonier, and RMP Company, another consulting firm working on ITT Rayonier's waste abatement project, met to discuss and coordinate design efforts. My involvement in the meeting included:

    A. Discussion of causes, location, and the effects of potential overflows on the plantsite.

    B. Discussion of the means by which the secondary treatment system could be bypassed.

    C. Discussion of preliminary conduit runs as presented by RMP Company and of alternatives where conflicts with yard piping were identified.

    D. Discussion of the status of CH_2M HILL's design efforts on thrust blocking for the yard piping.

    E. Discussion of the need for additional holes in the influent and return activated sludge diffusers in the aeration basin. These holes will allow for air release and minimize buoyancy while the aeration basin is filling.

19. Reviewed shop drawings submitted by Ershigs, Inc., on the FRP process piping under the secondary clarifiers.

20. Assisted with the preparation of minutes of the 16 March meeting with ITT Rayonier and RMP Company for distribution to the client and for future reference in-house.

21. Assisted another engineer with the final design of the waste activated sludge pipelines near the secondary treatment pumphouse.

22. On 18 March 1976, representatives of CH_2M HILL, ITT Rayonier, and Ershigs, Inc., supplier of the FRP yard piping, met to discuss modifications through which a more economical yard piping design might be achieved. My involvement in the meeting included:

    A. Presentation to ITT Rayonier of revised design drawings on modifications to the existing primary clarifier and detail drawings on the associated fabricated metal work.

B. Discussed the review comments I had made on the shop drawings of the FRP piping under the secondary clarifiers.

C. Discussion of the details of connecting the new treatment system bypass line to the existing primary clarifier influent line. This connection will make possible emergency bypassing of the entire treatment system.

D. Discussion of the end plugs for the influent and return activated sludge diffusers in the aeration basin.

E. Discussion of the waste activated sludge piping near the secondary treatment pumphouse.

F. Discussion of the economic advantage of using flexible couplings in place of flanged coupling adaptors for connections between RFP and stainless steel inserts at the various structures.

G. Discussion of the flexibility of Ershig's standard bell-and-spigot pipe joint.

H. Presentation of sketches of the concrete saddles to be used to support process piping in the aeration basin.

I. Discussion of the use of stainless steel joint harnesses on the bell-and-spigot pipe joints.

J. Discussion of the additional holes to be added to the influent and return activated sludge diffusers in the aeration basin to allow for air release and to minimize buoyancy while the basin is filling.

K. Discussion of concepts for using an FRP tank for the outfall junction structure.

L. Discussion of the need for flexibility throughout the yard piping design due to the excessive settlement that is predicted.

M. Discussion of the use of smooth turn elbows in place of mitered elbows in the yard piping system.

23. Made minor revisions and additions to the Aeration Basin Area Plan.

24. Began preparation of a worksheet showing details of the influent and return activated sludge diffusers in the aeration basin.

25. Prepared minutes of the 18 March meeting with ITT Rayonier and Ershigs, Inc., for distribution to the client and for future reference in-house.

26. Revised the design drawing of the FRP process piping under the secondary clarifiers.

27. Prepared an itemization of the quantity of cast iron pipe and the type and quantity of fittings needed for the scum piping system. This information was submitted to ITT Rayonier for use in preparation of a purchase order.

28. Computed forces due to thrust at the tees in the influent and return activated sludge piping in the aeration basin. CH_2M HILL structural engineers will base the design of appropriate concrete thrust blocking on the computed forces.

29. Revised the design drawing of the fabricated metal piping associated with the secondary clarifiers.

30. Coordinated structural design and review of the concrete saddles to be used to support process piping in the aeration basin.

31. On 31 March 1976, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

    A. Discussion of the preliminary site grading plan.

    B. Discussion of forming techniques for the secondary clarifier walls and launders.

    C. Presentation and discussion of preliminary mechanical and structural drawings of the aeration basin effluent structure.

    D. Presentation and discussion of preliminary design drawings of the concrete saddles to be used to support process piping in the aeration basin.

    E. Discussion of potential hydraulic problems in response to ITT Rayonier's request to raise the aeration basin water surface elevation approximately 6 inches.

    F. Discussion of CH_2M HILL's progress in reviewing shop drawings.

    G. Discussion of the design of the hot caustic extract (HCE) line and the quantity of pipe required.

32. Made revisions to two design drawings as necessitated by raising the aeration basin bottom elevation approximately 6 inches.

<u>April 1976</u>

1. Assisted with the preparation of minutes of the 31 March 1976 meeting with ITT Rayonier for distribution to the client and for future reference in-house.

2. Completed a preliminary design drawing showing details of the influent and return activated sludge diffusers in the aeration basin. The drawing was submitted to the client for review comments.

3. Made miscellaneous revisions to the secondary clarifier mechanical drawings per review comments by ITT Rayonier. These drawings were then issued for construction.

4. Coordinated revisions by CH_2M HILL's structural engineering department to the secondary clarifier structural drawings per review comments by ITT Rayonier. These drawings were then issued for construction.

5. Made miscellaneous revisions to preliminary drawings of the aeration basin effluent structure per review comments by ITT Rayonier. These drawings were then issued for construction.

6. Discussed design concepts with, and answered the questions of a senior design engineer who reviewed in detail the design drawings of the secondary clarifiers and the modifications which must be made to the existing primary clarifier when the new secondary treatment system becomes operational.

7. Discussed with CH_2M HILL's structural engineering department the review comments on the structural design of the secondary clarifiers that resulted from the review mentioned in No. 6.

8. Reviewed shop drawings submitted by Ershigs, Inc., on a portion of the fiberglass reinforced plastic (FRP) yard piping.

9. Reviewed the predictions of settlement around the secondary clarifiers which were prepared by Shannon & Wilson, a geotechnical consulting firm also working on ITT Rayonier's waste abatement project.

10. Sized and located additional holes to be added to the influent and return activated sludge diffusers in the aeration basin. These holes allow for air release and minimize buoyancy while the basin and pipelines are filling.

11. Designed and prepared a detail drawing of the connection between the existing primary clarifier influent line and a new effluent line which will serve as the treatment system emergency bypass. This drawing was then issued for construction.

12. Computed forces due to thrust at some critical locations in the yard piping system and coordinated completion of the remainder of these computations by another design engineer. CH_2M HILL structural engineers will base the design of appropriate concrete thrust blocking on the computed forces.

13. Revised the length of the footing drains around the perimeter of the secondary clarifiers.

14. Designed an air relief stand pipe for the return activated sludge line to the aeration basin and added it to the appropriate design drawings and shop drawings.

15. Made miscellaneous revisions related to influent, return activated sludge, and air piping on the Aeration Basin Area Plan and Yard Piping Profiles.

16. Reviewed the second submittal of Ershigs, Inc. shop drawings on the FRP process piping under the secondary clarifiers.

17. Discussed with Ershigs, Inc. modifications to the yard piping design that would facilitate fabrication of the pipe. Where appropriate, the modifications were made on the design drawings.

18. Assisted with the preparation of monthly design drawing and engineering status reports for March 1976. These reports were submitted to the client.

19. Finalized the sizing of the influent and return activated sludge diffuser piping and ports in the aeration basin using CH_2M HILL's computer program for diffuser analysis.

20. Re-ran CH_2m HILL's hydraulics computer program, using headloss data generated by diffuser program mentioned in No. 19, to update the hydraulic profile through the treatment plant. A problem area was identified and solutions were discussed with John Lee, the project manager.

21. On 22 April 1976, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

    A. Discussion of potential hydraulics problems in response to ITT Rayonier's request to raise the aeration basin water surface elevation approximately 6 inches.

    B. Discussion of redesigning the fabricated metal transition piece which will connect the primary clarifier effluent box to the FRP influent line to the aeration basin. A redesign will decrease the headloss and eliminate the problem identified in No. 20 and discussed in No. 21A.

    C. Discussion of the method of installation to be used in connecting the primary clarifier outlet box, the fabricated metal transition piece, and the FRP influent pipeline to the aeration basin.

    D. Discussion of ITT Rayonier's standard criteria for pressure testing pipelines and the influence of these criteria on the design requirements of thrust blocks for the yard piping.

E. Discussion of the magnitude of potential surge pressures that might develop in the return activated sludge line to the aeration basin.

F. Discussion of sketches presented by a CH_2M HILL structural engineer showing several types of thrust blocks which might be used for the yard piping.

G. Discussion of the sequence of laying the pipelines in the aeration basin.

H. Discussion of special concrete saddles to support the influent and return activated sludge pipelines on the slope of the aeration basin dike.

22. Reviewed and itemization of the quantity of stainless steel pipe and the type and quantity of fittings needed for the hot caustic extract (HCE) piping system. The itemization was prepared by another design engineer and, after review, was submitted to ITT Rayonier for use in preparation of a purchase order.

23. Assisted with the preparation of minutes of the 22 April meeting for distribution to the client and for future reference in-house.

24. Discussed with John Lee, the project manager, the review comments of the senior design engineer who conducted the design drawing review mentioned in No. 5.

25. Made revisions to the secondary clarifier mechanical design in response to the review comments mentioned in No. 24.

26. Reviewed the second submittal by Dorr-Oliver, the secondary clarifier mechanism supplier, of shop drawings on the concrete details for the clarifier tanks.

27. Calculated headloss through the grating over the secondary clarifier outlet boxes using several different methods.

28. Set up for drafting a worksheet on the outfall junction structure (structure at which the new secondary clarifier effluent lines connect with the existing outfall line) from sketches prepared by another design engineer.

29. On 29 April 1976, representatives of ITT Rayonier and CH_2M HILL met to discuss the progress of design efforts. My involvement in the meeting included:

A. Review of the changes made to the secondary clarifier mechanical and structural drawings in response to the review comments mentioned in No. 24.

B. Discussion of the comments that I noted in reviewing Dorr-Oliver's shop drawings on the concrete details of the secondary clarifier tanks.

C. Informing the client that I had provided Ershigs, Inc., the yard piping supplier, with necessary information about the secondary clarifier design to enable them to check the structural adequacy of the FRP piping which they recommended for use under the clarifiers.

D. Discussion of the settlement of the aeration basin dikes and its effect on piping in the vicinity.

30. In a brief in-house meeting, discussed the techniques used for cutting and field welding FRP pipe.

31. Revised the secondary clarifier weir and scum baffle detail to conform with the shop drawings submitted by Dorr-Oliver.

<u>May 1-14, 1976</u>

1. Reviewed shop drawings submitted by Ershigs, Inc., on portions of the fiberglass-reinforced plastic (FRP) yard piping.

2. Reviewed the concept and location of the thrust blocks and pipe supports for the aeration basin influent and return activated sludge lines located on the aeration basin dike and floor. Preliminary work was done by a CH_2M HILL structural engineer.

3. Prepared a letter to Ershigs, Inc., providing the necessary information about the secondary clarifier design to enable them to check the structural adequacy of the FRP piping that they recommended for use under the clarifiers.

4. Discussed and initiated the design by other project engineers of a washdown waterpump and piping system to serve the treatment area.

5. On 7 May 1976, representatives of ITT Rayonier, Ershigs, Inc., and CH_2M HILL met to discuss the progress of design efforts and particularly the strength requirements of the FRP piping to be placed under the secondary clarifiers. My involvement in the meeting included:

   A. Discussion of a profile of the loading to which the under-clarifier piping would be subjected. This was prepared by a CH_2M HILL structural engineer.

   B. Discussion of both fabrication and design alternatives to consider should the FRP pipe as previously recommended by Ershigs prove inadequate.

C. Reporting on the status of my review of Ershigs shop drawings.

D. Discussion of a potential conflict between piling locations and yard piping locations as presently designed.

E. Presentation of preliminary layout drawings on the outfall junction structure (structure at which the new secondary clarifier effluent lines connect to the existing outfall line).

6. Assisted with the preparation of minutes of the 7 May meeting for distribution to the client and for future reference in-house.

7. Began preparation of a memorandum to the client, which identified:

   A. Criteria and assumptions used in the hydraulic design of the treatment facility.

   B. Problems encountered in the design and the design modifications made to resolve them.

   C. The hydraulic limitations of the treatment facility as presently designed.

   D. Field changes that can be made in the future to minimize or eliminate certain hydraulic limitations.

8. At the client's request, reviewed the characteristics of the R. H. Baker & Co., Inc., flexible couplings and flanged coupling adaptors to determine their acceptability for various application throughout the treatment facility.

9. Ran CH_2M HILL's hydraulics computer program to determine if overflow conditions exist when plant flow reaches 33.5 mgd.

APPENDIX C

A Summary of the Capabilities of the Computer Program, HYDRO

H Y D R O

INTRODUCTION

Computer program HYDRO computes the energy grade line elevations and hydraulic grade line elevations on the upstream and downstream sides of the hydraulic elements that commonly occur in a wastewater or water treatment plant. The hydraulic analysis begins at the downstream end of the plant and proceeds upstream, one element at a time. The hydraulic parameters on the downstream side of each element are set in one of three ways:

(1) They may be equated to the upstream parameters of the downstream element;

(2) They may be specified directly by calling the initializing subroutine HYD00, which is described later;

(3) They may be computed based on minimum specific energy considerations, which are discussed in conjunction with the open channel and launder elements.

The advantages of computer analysis over hand computations are:

(1) The cost can be reduced, particularly for large jobs;

(2) The time required to obtain a solution can generally be reduced;

(3) Once the algorithms have been thoroughly tested, computer results are more reliable, precise, and desirable than manual calculations because:

   (a) Computational errors are eliminated;

   (b) Computational procedures that are prohibitive by hand are performed routinely by the computer, which prevents short-cut approximations;

   (c) Errors in procedure are minimized;

   (d) Computational procedures are standardized.

(4) The review of concepts and computations by a second person is reduced.

The program was developed using standard Fortran IV programming language conventions. A minimal number of machine dependent subroutines are used, and these routines generally have a counterpart that performs the same function on other systems. Only 71 columns are used for output to accomodate teletype printouts and 8-1/2 by 11 inch notebooks. Data can be input by terminal or cards and output can be via terminal or line printer. All output from each element appears on the same page. If insufficient room exists for the output from an element, heading information is written at the top of the next page and the output for the element follows. The heading information consists of title information, date, time, page number, and three primary flow rates.

The computer program is structured so the main program reads and interprets input data and then calls the appropriate subroutine to perform the hydraulic computations. Output essential to that hydraulic element is printed and control is returned to the main program. Some of the subroutines are used for more than one element, such as subroutine HYD01, which is used for full conduit circular and rectangular pipe flow and also annular pipe flow.

Since wastewater and water treatment plants are generally designed to conserve available hydraulic head, subcritical flow is assumed to exist in open channel sections. Critical or supercritical flow is not considered except at control sections.

The hydraulic elements are identified in the computer program by the variable IDNUM, as shown in Table 1.

TABLE 1.
HYDRAULIC ELEMENTS ANALYZED BY HYDRO

IDNUM	ELEMENT
0	Initialization of energy grade line (EGL), hydraulic grade line (HGL), 3 flow rates, velocity, and element sequence number.
1	Circular pipe flowing full.
2	Rectangular pipe flowing full.
3	V-notch weir.
4	Rectangular weir.
5	Circular section open channel flow.
6	Rectangular or trapezoidal section open channel flow.
7	Circular orifice or gate.
8	Rectangular orifice or gate.
9	Parshall flume.
10	Arbitrary head loss.
11	Circular launder.
12	Rectangular or trapezoidal launder.
13	Rectangular or trapezoidal open channel transition.
14	Annular pipe flow.
15	Obstruction loss in a full circular pipe.
16	Rectangular or trapezoidal launder transition.
17	Underflow gate (sluice gate).
18	Side channel weir in rectangular channel with flow exiting.
19	Bar rack.
20	Rectangular pressure transition.
21	Comminutor.
22	Store current hydraulic parameters.
23	Retrieve hydraulic parameters stored by element 22.
24	Sudden expansion loss.
25	Circular pipe flowing full, Darcy-Weisbach equation.
26	Port diffuser.

APPENDIX D

Major Yard Piping Specifications

SPECIFICATIONS FOR WASTE ABATEMENT PROGRAM
PROJECT N72/7
SECONDARY TREATMENT SYSTEM
YARD PIPING

A. SCOPE

THIS SPECIFICATION COVERS ALL WORK NECESSARY TO FURNISH AND DELIVER THE FIBERGLASS REINFORCED PLASTIC (FRP) OR REINFORCED PLASTIC MORTAR (RPM) YARD PIPING AND FITTINGS HEREINAFTER SPECIFIED COMPLETE AND READY FOR INSTALLATION.

BID INFORMATION.

THE VENDOR SHALL QUOTE HIS STANDARD RECOMMENDED DESIGN AND MATERIAL FOR THIS INSTALLATION AS DESCRIBED HEREINAFTER AND INDICATED ON DRAWINGS 2001-PRE, 2005M-PRE, SK 2109, 2200M-PRE, SK 2110, 2007M-PRE, 2008M-PRE, 2009M-PRE, SK 2111, ATTACHED. THE VENDOR SHALL SUBMIT WITH HIS PROPOSAL COMPLETE SPECIFICATIONS, DESCRIPTIVE LITERATURE, AND DATA. DATA SUBMITTED SHALL INCLUDE, BUT NOT BE LIMITED TO, THE FOLLOWING:

1. DETAIL DIMENSIONS OF ALL FITTINGS AND PIPING.

2. MECHANICAL, THERMAL, AND PHYSICAL PROPERTIES.

3. PRESSURE AND THERMAL SERVICE RATINGS.

4. MAXIMUM AND MINIMUM BURIAL DEPTHS AND VACUUM RESISTANCE DATA.

5. A JOINT DETAIL AND A COMPLETE DESCRIPTION OF THE RECOMMENDED JOINING PROCESS.

6. ANY OTHER DATA THE MANUFACTURER FEELS PERTINENT TO THE PROPER EVALUATION OF HIS MATERIAL.

THE ATTACHED DRAWINGS ARE PRELIMINARY IN NATURE AND ISSUED FOR THE PURPOSE OF DEFINING THE ROUGH QUANTITIES OF MATERIALS AND FITTINGS REQUIRED FOR THE PROJECT. EACH VENDOR IS CAUTIONED THAT A COMPLETE EVALUATION OF HIS PRODUCT WILL BE CONDUCTED. AWARD WILL BE BASED UPON PRODUCT ACCEPTABILITY AS WELL AS PRICE.

THE VENDOR'S ATTENTION IS DIRECTED TO THE 'INSTRUCTIONS TO BIDDERS' (DRAWING LS-N727/19M) FOR ADDITIONAL BID

INFORMATION. IN THE EVENT OF DISCREPANCY BETWEEN THE 'INSTRUCTIONS TO BIDDERS' AND THE 'SPECIFICATION,' THE SPECIFICATION SHALL GOVERN.

B. GENERAL SPECIFICATION

1. SINCE QUANTITIES MAY VARY FROM THOSE INDICATED, PRICES OF PIPING AND FITTINGS ARE TO BE ITEMIZED.

2. PRICES ARE TO BE F.O.B. CUSTOMER'S PLANT AT HOQUIAM, WASHINGTON.

3. SHIPPING DATE AFTER RECEIPT OF PURCHASE ORDER SHALL BE INDICATED.

4. ALL PIPING AND FITTINGS SHALL HAVE AN ULTRAVIOLET BARRIER.

C. DEFINITIONS

FRP PIPE.

FRP PIPE SHALL BE REINFORCED THERMOSETTING RESIN PIPE, TYPE 1, GRADE 2, CLASS E, AS DEFINED IN ASTM D 2310-71.

RPM PIPE.

RPM PIPE SHALL BE AS DEFINED IN ASTM D 3262-73, SECTION 4.2.

FILAMENT WOUND.

FILAMENT WOUND SHALL BE DEFINED AS MACHINE MANUFACTURED BY THE FILAMENT WINDING PROCESS. FILAMENT WINDING SHALL BE AS DEFINED IN ASTM D 2310-71, SECTION 2.3.

GENERAL NOMENCLATURE.

THE NOMENCLATURE IS IN ACCORDANCE WITH ASTM D 883, 'NOMENCLATURE RELATING TO PLASTICS,' AND ASTM D 1600, 'ABBREVIATIONS OF TERMS RELATING TO PLASTICS,' UNLESS OTHERWISE INDICATED.

D. MATERIALS

PIPE.

THE PIPE SHALL BE FRP OR RPM PIPE OF FILAMENT-WOUND CONSTRUCTION. THE STRUCTURE OF THE PIPE SHALL BE A COMPOSITE CONSISTING OF A CURED THERMOSETTING RESIN BINDER AND IMBEDDED FIBERGLASS

REINFORCEMENT. THE PIPE SIZE SHALL BE THE INSIDE DIAMETER IN INCHES AS SHOWN ON THE ATTACHED DRAWINGS AND SPECIFIED BELOW. THE INSIDE DIAMETER OF THE PIPE SHALL BE CONSISTENT WITH THE INSIDE DIAMETER OF THE FITTINGS. THE PIPE SHALL BE SUPPLIED IN THE NOMINAL LAYING LENGTH SPECIFIED BELOW AND SHALL BE MANUFACTURED AT THIS LENGTH WITH NO INTERMEDIATE JOINTS ALLOWED. THE FIELD JOINT SHALL BE BELL-AND-SPIGOT OR FLANGED AS SPECIFIED BELOW WITH A MINIMUM DESIGN WORKING PRESSURE AS REQUIRED FOR THE SPECIFIED SERVICE.

SERVICE.

THE PIPING SHALL BE INSTALLED NEAR A SULFITE PULP MILL. THE LIQUIDS CONVEYED AND THEIR CHARACTERISTICS SHALL BE AS SPECIFIED BELOW.

RESIN.

THE RESIN SHALL BE A CATALYZED POLYESTER THERMO-SETTING RESIN SELECTED ON THE BASIS OF ITS PROVEN RESISTANCE TO THE TRANSPORTED LIQUIDS. ALL RESINS SHALL BE OF COMMERCIAL GRADE AS SUPPLIED AND SHALL NOT CONTAIN MORE THAN 50 PERCENT STYRENE BY WEIGHT.

RPM AGGREGATE.

THE AGGREGATE FILLER USED IN MANUFACTURING RPM PIPE SHALL BE A SILICEOUS SAND CONFORMING TO THE REQUIREMENTS OF THE CURRENT SPECIFICATIONS FOR CONCRETE AGGREGATE, ASTM C 33, EXCEPT THAT THE REQUIREMENTS FOR GRADATION SHALL NOT APPLY.

FIBERGLASS REINFORCEMENT.

THE FIBERGLASS REINFORCEMENT SHALL BE COMMERCIAL GRADE 'E' GLASS FIBER HAVING A COUPLING AGENT THAT WILL PROVIDE A SUITABLE BOND BETWEEN THE GLASS AND THE RESIN.

LAMINATE CONSTRUCTION.

THE LINER SHALL BE A REINFORCED THERMOSETTING RESIN WITHOUT AGGREGATE FILLER.

INNER SURFACE

BETWEEN 0.010 AND 0.020 INCH OF REINFORCED RESIN-RICH SURFACE SHALL BE PROVIDED. THIS

SURFACE IS TO BE REINFORCED WITH 10-MIL 'C' GLASS SURFACING VEIL UNLESS OTHERWISE SPECIFIED.

INTERIOR LAYER

THE INTERIOR LAYER OF THE LAMINATE SHALL BE COMPOSED OF A MINIMUM OF TWO LAYERS OF CHOPPED STRAND FIBERGLASS SATURATED WITH RESIN. GLASS CONTENT SHALL BE BETWEEN 20 PERCENT AND 30 PERCENT, AND THE THICKNESS SHALL BE APPROXIMATELY 0.10 INCH.

FITTINGS AND SPECIALS.

ALL FITTINGS SHALL BE FABRICATED FROM ACCEPTABLE PIPE AND SHALL BE FORMED BY JOINING MITER-CUT PIPE SECTIONS WITH OVERLAYS OF RESIN-SATURATED GLASS FABRIC. ALL FITTING DIMENSIONS SHALL CONFORM TO AWWA C 208-59, TABLE 1 AND FIGURE 1, UNLESS OTHERWISE SPECIFIED, AND SHALL MEET OR EXCEED PROJECT DESIGN REQUIREMENTS FOR PIPE. FITTINGS SHALL BE FURNISHED WITH THE TYPE OF JOINT SPECIFIED. SPECIALS SHALL MEET OR EXCEED PROJECT DESIGN REQUIREMENTS FOR PIPE AND SHALL BE FURNISHED WITH THE TYPE OF JOINT SPECIFIED.

BELL-AND-SPIGOT JOINTS.

BELL-AND-SPIGOT JOINTS SHALL BE SEALED WITH A GASKET MANUFACTURED FROM SYNTHETIC RUBBER. THE GASKET SHALL BE A CONTINUOUS RING WITH A ROUND CROSS SECTION, EXTRUDED OR MOLDED, AND SHALL CONFORM TO ASTM C 361, SECTION 5.9. LUBRICANT FOR JOINTING SHALL BE AS APPROVED BY THE PIPE MANUFACTURER. THE SPIGOT SHALL BE SELF-CENTERED WITHIN THE BELL UPON PROPER ASSEMBLY OF THE JOINT. THE GASKET SHALL BE UNIFORMLY CONFINED WITHIN A GASKET GROOVE AND ENCLOSED ON FOUR SIDES. IN THIS CONDITION THE GASKET SHALL NOT SUPPORT THE WEIGHT OF THE PIPE AND SHALL FUNCTION SOLELY AS A SEALING ELEMENT UNDER ALL NORMAL CONDITIONS OF SERVICE, INCLUDING PIPE EXPANSION AND CONTRACTION AND EARTH SETTLEMENT.

FLANGED JOINTS.

VAN-STONE-TYPE FLANGES WITH CAST-STEEL BACKING RINGS SHALL BE SUPPLIED FOR FLANGED JOINTS ON EXPOSED PIPING UNLESS OTHERWISE INDICATED. FLANGE THICKNESS SHALL BE 1/2-INCH MINIMUM, OR 1-1/2 TIMES THE WALL THICKNESS, WHICHEVER IS GREATER. CAST-STEEL BACKING RINGS SHALL BE PER SHEET 1, ATTACHED.

FULL-FACE DRILLED FLANGES SHALL BE SUPPLIED FOR FLANGED JOINTS ON BURIED PIPING AND WHERE EXPOSED PIPING CONFIGURATIONS PRECLUDE THE USE OF VAN-STONE FLANGES.

WHEN FLANGES ARE ADDED TO PIPE OR FITTINGS, THE MINIMUM FLANGE HUB SHEAR SURFACE SHALL BE FIVE TIMES THE FLANGE THICKNESS. WHENEVER POSSIBLE, A SEPARATE FLANGED STUB END SHALL BE USED. IN EITHER CASE, THE GLASS REINFORCEMENT SHALL BE CONTINUOUS FROM THE FLANGE INTO THE HUB.

FASTENERS AND GASKETS FOR ALL FLANGED CONNECTIONS SHALL BE PROVIDED BY THE CUSTOMER. METAL WASHERS SHALL BE USED UNDER BOLT HEADS AND NUTS IN CONTACT WITH THE FRP OR RPM. GASKET MATERIAL SHALL HAVE SHORE A HARDNESS OF 50 TO 60. CONNECTIONS BETWEEN DIFFERENT TYPES OF FLANGES SHALL BE IN ACCORD WITH SHEET 2, ATTACHED.

E. <u>WORKMANSHIP</u>

PIPE.

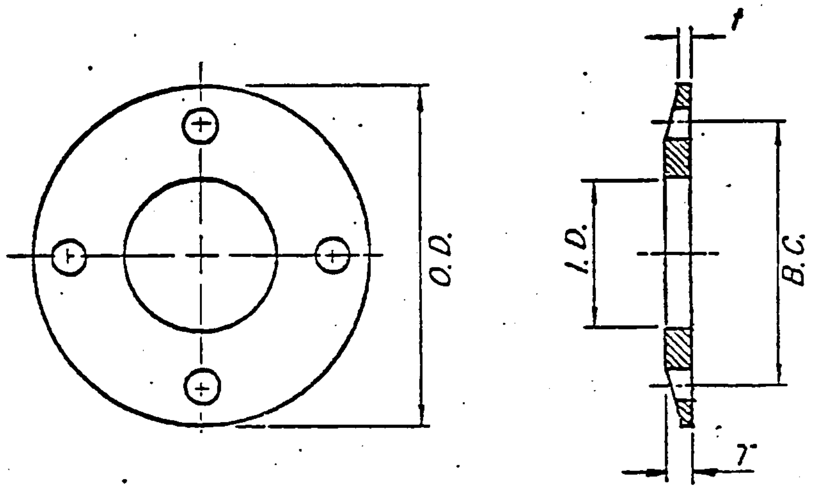
THE PIPES SHALL BE FREE OF ANY CRACKS, POROSITY, DELAMINATION, BUBBLES, FLAT SPOTS, EXPOSED OR WRINKLED GLASS FIBERS, VOIDS, OR PITS GREATER THAN 1/4 INCH IN SIZE BY 1/32 INCH DEEP, GROOVES GREATER THAN 1/16 INCH DEEP, OR RIDGES GREATER THAN 1/16 INCH HIGH. THE PIPE SHALL ALSO BE FREE OF ANY DRY SPOTS THAT OCCUR ON THE EXTERIOR OR INTERIOR SURFACE OF THE PIPE WHERE THE GLASS ROVING OR CLOTH IS NOT THOROUGHLY WET-OUT WITH RESINS.

NO GLASS FIBER REINFORCEMENT SHALL PENETRATE THE INNER SURFACE OF THE PIPE WALL OR THE INNER SURFACE OF THE BELL-AND-SPIGOT GROOVE. ALL JOINT SEALING SURFACES SHALL BE FREE FROM DENTS, GOUGES, CRACKS, POROSITY, BUBBLES, VOIDS, DRY SPOTS, EXPOSED GLASS ROVING, AND WRINKLED VEIL CLOTH THAT AFFECT THE INTEGRITY OF THE JOINT.

MARKING.

ALL SPOOLS AND/OR ASSEMBLIES SHALL HAVE THE PART OR MARK NUMBER PLAINLY AFFIXED THEREON. NUMBERING SHALL BE CROSS-REFERENCED TO THE DESIGN DRAWINGS, PER CUSTOMER-VENDOR AGREEMENT.

ALL STANDARD PIPE AND FITTINGS WHICH REQUIRE MODIFICATIONS AFTER MANUFACTURE SUCH AS DRILLING, ATTACHMENT OF BRANCH NOZZLES, ETC., SHALL BE SUPPLIED WITH A UNITED ASSOCIATION OF PIPEFITTERS UNION LABEL (U.A. LABEL).



F.R.P. PIPE SIZE	I.D.	O.D.	B.C.	T	t	NO. HOLES	HOLE SIZE	APPROX. SHIP. WT.
1-1/2	2-3/16	5	3-7/8	1/2	3/8	4	5/8	2.0
2	2-11/16	6	4-3/4	5/8	3/8	4	3/4	2.9
2-1/2	3-3/16	7	5-1/2	5/8	3/8	4	3/4	3.8
3	3-11/16	7-1/2	6	5/8	3/8	4	3/4	4.7
4	4-11/16	9	7-1/2	5/8	3/8	8	3/4	6.2
6	6-7/8	11	9-1/2	3/4	3/8	8	7/8	9.8
8	8-7/8	13-1/2	11-3/4	3/4	3/8	8	7/8	14.0
10	11	16	14-1/4	7/8	1/2	12	1	20.5
12	13	19	17	7/8	1/2	12	1	29.1
14	15	21	18-3/4	1	1/2	12	1-1/8	35.4
16	17	23-1/2	21-1/4	1	1/2	16	1-1/8	42.4
18	19-1/4	25	22-3/4	1-1/8	5/8	16	1-1/4	50.4
20	21-1/2	27-1/2	25	1-1/8	5/8	20	1-1/4	59.4
24	25-1/2	32	29-1/2	1-1/8	5/8	20	1-3/8	69.0
30	31-1/2	38-3/4	36	1-1/8	1-1/8	28	1-3/8	107
36	37-1/2	46	42-3/4	1-1/8	1-1/8	32	1-5/8	162
42	43-3/4	53	49-1/2	1-1/8	1-1/8	36	1-5/8	230

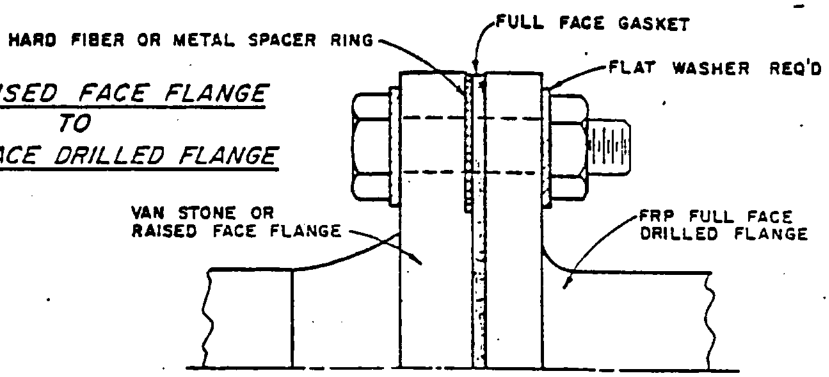
BOLTING PATTERN

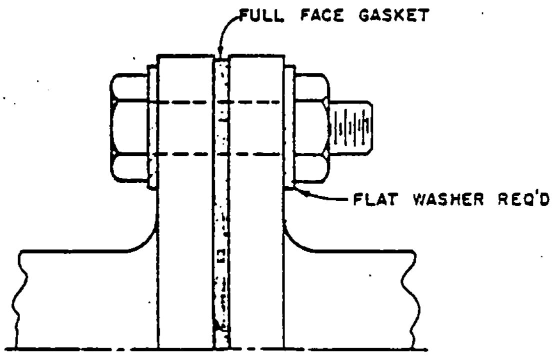
1-1/2" THRU 24" SIZES: ASA STD. B16.5 FOR 150 LB. STEEL FLANGES.

30" THRU 48" SIZES: ASA STD. B16.1 FOR 125 LB. C.I. FLANGES.

FRP AND RPM PIPE AND FITTINGS STEEL BACKING FLANGE		
ISSUED REVISED	SHEET NO. 1	REV.

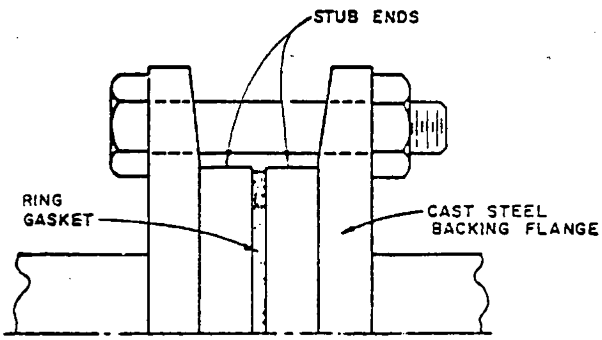
METAL RAISED FACE FLANGE TO FRP FULL FACE DRILLED FLANGE





FRP FULL FACE DRILLED FLANGES

FRP STUB ENDS W/BACKING FLANGES



GASKET REQUIREMENTS

1. USE FULL FACE OR RING GASKET AS INDICATED IN SKETCHES.
2. SHORE DUROMETER TO BE 50-60.
3. TYPICAL GASKET MATERIAL: RED RUBBER, NEOPRENE, TYGON
4. 1/8" MINIMUM THICKNESS.

FLANGE CONNECTIONS		
ISSUED REVISED	SHEET NO. 2	REV.

YARD PIPING SPECIFICATION SHEET NO. 3
NORTH SECONDARY CLARIFIER INFLUENT

DESCRIPTION:

APPROXIMATELY THREE HUNDRED FORTY-THREE LINEAL FEET (343') OF 36-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL BENDS AND A 10-FOOT DROP AT A 40-DEGREE SLOPE TOWARD ONE END OF THE RUN. EXCEPT AS NOTED, PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS AND SPECIALS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 39° BEND
ONE (1) SPIGOT X BELL 39° BEND
ONE (1) SPIGOT X BELL 33° BEND
ONE (1) SPIGOT X BELL 3° BEND
ONE (1) SPIGOT X BELL 36° BEND
ONE (1) SPIGOT X BELL 2.5° BEND
TWO (2) SPIGOT X BELL 34° BENDS
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 4-FOOT SECTION

SERVICE:

CARRY ACTIVATED SLUDGE MIXED LIQUOR UNDER A MAXIMUM HEAD OF 30 FEET. TOTAL SUSPENDED SOLIDS IN MIXED LIQUOR - 2,000 TO 2,500 MG/L. PH OF MIXED LIQUOR - 6.5 TO 7.5. TEMPERATURE OF MIXED LIQUOR - 50° TO 90°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE UPON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FROM APPROXIMATELY STA. 3+94.5 TO STA. 4+29.

YARD PIPING SPECIFICATION SHEET NO. 4
NORTH SECONDARY CLARIFIER RAS

DESCRIPTION:

APPROXIMATELY SEVENTY-NINE LINEAL FEET (79') OF 30-INCH I.D. BELL-AND-SPIGOT PIPING IN A STRAIGHT ATTITUDE WITH A 6-FOOT DROP AT A 42.5-DEGREE SLOPE AT ONE END OF THE RUN. EXCEPT AS NOTED, PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 30° BEND
TWO (2) SPIGOT X BELL 38.5° BENDS
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) SECTION

SERVICE:

CARRY ACTIVATED SLUDGE UNDER A MAXIMUM HEAD OF 30 FEET. CONSISTENCY OF ACTIVATED SLUDGE - 1/2-PERCENT TO 1-1/2-PERCENT SOLIDS. PH OF ACTIVATED SLUDGE - 6.5 TO 7.5. TEMPERATURE OF ACTIVATED SLUDGE - 50° TO 90°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE UPON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

YARD PIPING SPECIFICATION SHEET NO. 5A
NORTH AND WEST SECONDARY CLARIFIER EFFLUENT
(TREATMENT SYSTEM BYPASS)

DESCRIPTION:

APPROXIMATELY ONE HUNDRED EIGHTY-FIVE LINEAL FEET (185') OF 30-INCH I.D. BELL-AND-SPIGOT PIPING AND APPROXIMATELY FIFTEEN LINEAL FEET (15') OF 24-INCH I.D. FLANGED (FACTORY ATTACHED) PIPING. THE 30-INCH I.D. PIPING INCLUDES ONE HORIZONTAL BEND AND AN 11-FOOT RISE AT A 42.5-DEGREE SLOPE AT ONE END OF THE RUN. THE 24-INCH I.D. PIPING IS IN A STRAIGHT ATTITUDE. EXCEPT AS NOTED, THE 30-INCH I.D. PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. THE 24-INCH I.D. PIPING WILL BE SUPPLIED AS NOTED.

FITTINGS:

ONE (1) 30-INCH FLANGED (FACTORY ATTACHED) X SPIGOT 12-FOOT SECTION
ONE (1) 30-INCH BELL X SPIGOT 42° BEND
ONE (1) 30-INCH X 30-INCH X 24-INCH BELL-AND-SPIGOT TEE
ONE (1) 30-INCH BELL X SPIGOT 43° BEND
ONE (1) 30-INCH (BELL) X 24-INCH (FACTORY ATTACHED FLANGED) 90° BEND
ONE (1) 24-INCH FLANGED X FLANGED (FACTORY ATTACHED) 1-FOOT SECTION
ONE (1) 24-INCH X 24-INCH X 24-INCH FLANGED (FACTORY ATTACHED) TEE
ONE (1) 24-INCH FLANGED X FLANGED (FACTORY ATTACHED) 2-FOOT SECTION
ONE (1) 30-INCH (PLAIN END) X 30-INCH (PLAIN END) X 24-INCH (FACTORY ATTACHED FLANGED) TEE
ONE (1) 24-INCH FLANGED (FACTORY ATTACHED) 90° BEND
ONE (1) 24-INCH FLANGED X FLANGED (FACTORY ATTACHED) 10-FOOT SECTION

SERVICE:

NORMAL: CARRY SECONDARY TREATED EFFLUENT UNDER A MAXIMUM HEAD OF 30 FEET. TOTAL SUSPENDED SOLIDS IN EFFLUENT WILL BE MINIMAL. PH OF EFFLUENT - 6.5 TO 7.5. TEMPERATURE OF EFFLUENT - 50° TO 90°F.

WHEN BYPASSING: CARRY PUMPED SULFITE PULP MILL AND PAPER MACHINE EFFLUENT OF LESS THAN 1 PERCENT CONSISTENCY UNDER A MAXIMUM HEAD OF 45 FEET. PH OF THE EFFLUENT - 3.0 TO 4.0. TEMPERATURE OF THE EFFLUENT - 50° TO 100°F. BYPASSING WILL OCCUR ONLY AS AN EMERGENCY MEASURE IN THE EVENT OF MECHANICAL FAILURE IN THE PRIMARY CLARIFIER.

YARD PIPING SPECIFICATION SHEET NO. 58
NORTH AND WEST SECONDARY CLARIFIER EFFLUENT
(TREATMENT SYSTEM BYPASS)

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE UPON PREPL'CED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FROM APPROXIMATELY STA. 0+20 TO STA. 1+51.

YARD PIPING SPECIFICATION SHEET NO. 6
WEST SECONDARY CLARIFIER INFLUENT

DESCRIPTION:

APPROXIMATELY THREE HUNDRED LINEAL FEET (300') OF 36-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL BENDS AND A 12-FOOT DROP AT A 10.5-DEGREE SLOPE TOWARD ONE END OF THE RUN. EXCEPT AS NOTED, THE PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 2-FOOT SECTION
ONE (1) SPIGOT X BELL 9.5° BEND
ONE (1) SPIGOT X BELL 69° BEND
ONE (1) SPIGOT X BELL 9° BEND
ONE (1) SPIGOT X BELL 56° BEND
ONE (1) SPIGOT X BELL 34° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 5-FOOT SECTION

SERVICE:

SAME AS NORTH SECONDARY CLARIFIER INFLUENT, SHEET NO. 3.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE UPON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FROM APPROXIMATELY STA. 0+84 TO STA. 0+98 AND FROM STA. 3+57 TO STA. 3+84.

YARD PIPING SPECIFICATION SHEET NO. 7
WEST SECONDARY CLARIFIER RAS

DESCRIPTION:

APPROXIMATELY ONE HUNDRED TWELVE LINEAL FEET (112') OF 30-INCH I.D. BELL-AND-SPIGOT PIPING AT A NEARLY CONSTANT GRADE WITH TWO HORIZONTAL BENDS. EXCEPT AS NOTED THE PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 2-FOOT SECTION
ONE (1) SPIGOT X BELL 51° BEND
ONE (1) SPIGOT X BELL 3° BEND
ONE (1) SPIGOT X BELL 66.5° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) SECTION

SERVICE:

SAME AS NORTH SECONDARY CLARIFIER RAS, SHEET NO. 4.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE UPON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FROM APPROXIMATELY STA. 0+84 TO STA. 1+02.

YARD PIPING SPECIFICATION SHEET NO. 8
WEST SECONDARY CLARIFIER EFFLUENT

DESCRIPTION:

APPROXIMATELY SEVEN LINEAL FEET (7') OF 24-INCH I.D. PIPING INSTALLED VERTICALLY. THE PIPING WILL BE SUPPLIED AS NOTED.

FITTINGS:

ONE (1) FLANGED X FLANGED (FACTORY ATTACHED) 90° BEND
ONE (1) FLANGED (FACTORY ATTACHED) X SPIGOT 7-FOOT SECTION

SERVICE:

SAME AS NORTH AND WEST SECONDARY CLARIFIER EFFLUENT (TREATMENT SYSTEM BYPASS), SHEET NO. 5A.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

YARD PIPING SPECIFICATION SHEET NO. 9
SOUTH SECONDARY CLARIFIER INFLUENT

DESCRIPTION:

APPROXIMATELY ONE HUNDRED THIRTY LINEAL FEET (130') OF 36-INCH I.D. BELL-AND-SPIGOT PIPING WITH TWO HORIZONTAL BENDS AND A 15-FOOT DROP AT A 34.5-DEGREE SLOPE AT ONE END OF THE RUN. EXCEPT AS NOTED, THE PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 89.5° BEND
ONE (1) SPIGOT X BELL 34° BEND
ONE (1) SPIGOT X BELL 33.5° BEND
ONE (1) SPIGOT X BELL 34° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 7-FOOT SECTION

SERVICE:

SAME AS NORTH SECONDARY CLARIFIER INFLUENT, SHEET NO. 3.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE UPON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FROM APPROXIMATELY STA. 1+89 TO STA. 2+14.

YARD PIPING SPECIFICATION SHEET NO. 10
SOUTH SECONDARY CLARIFIER RAS

DESCRIPTION:

APPROXIMATELY NINETY-ONE LINEAL FEET (91') OF 30-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL BENDS AND AN 11-FOOT DROP AT A 12.5-DEGREE SLOPE TOWARD ONE END OF THE RUN. THE PIPING WILL BE SUPPLIED AS NOTED. PIPING UNDER THE CLARIFIER WILL NOT BE INC_UDED.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 82° BEND
ONE (1) SPIGOT X BELL 3-FOOT SECTION
ONE (1) SPIGOT X BELL 8.5° BEND
ONE (1) SPIGOT X BELL 23-FOOT SECTION
ONE (1) SPIGOT X BELL 34° BEND
ONE (1) SPIGOT X BELL 19-FOOT SECTION
ONE (1) SPIGOT X BELL 12.5° BEND
ONE (1) SPIGOT X BELL 8-FOOT SECTION
ONE (1) SPIGOT X BELL 20-FOOT SECTION
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 10-FOOT SECTION

SERVICE:

SAME AS NORTH SECONDARY CLARIFIER RAS, SHEET NO. 4.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

YARD PIPING SPECIFICATION SHEET NO. 11
SOUTH SECONDARY CLARIFIER EFFLUENT

DESCRIPTION:

APPROXIMATELY NINETEEN LINEAL FEET (19') OF 24-INCH I.D. PIPING IN A STRAIGHT ATTITUDE AT A CONSTANT GRADE. THE PIPING WILL BE SUPPLIED AS NOTED.

FITTINGS:

ONE (1) FLANGED X FLANGED (FACTORY ATTACHED) 19-FOOT SECTION.

SERVICE:

SAME AS NORTH AND WEST SECONDARY CLARIFIER EFFLUENT (TREATMENT SYSTEM BYPASS), SHEET NO. 5A.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

YARD PIPING SPECIFICATION SHEET NO. 12A
RETURN ACTIVATED SLUDGE TO AERATION BASIN

DESCRIPTION:

APPROXIMATELY FOUR HUNDRED TWELVE LINEAL FEET (412') OF 36-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL AND VERTICAL BENDS. EXCEPT AS NOTED, BURIED PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. EXPOSED PIPING WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 2-FOOT SECTION
ONE (1) SPIGOT X BELL 59° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 13-FOOT SECTION
ONE (1) FLANGED (FACTORY ATTACHED) X BELL 41.5° BEND WITH
  FLANGED 8-INCH DIAMETER TEE SADDLE
ONE (1) SPIGOT X BELL 5-FOOT SECTION
ONE (1) SPIGOT X BELL 47.5° BEND
ONE (1) SPIGOT X BELL 16-FOOT SECTION
TWO (2) SPIGOT X BELL 34° BENDS
ONE (1) SPIGOT X BELL 2-FOOT SECTION
ONE (1) SPIGOT X BELL 19° BEND
ONE (1) SPIGOT X BELL 26.5° BEND
ONE (1) 36-INCH X 36-INCH X 36-INCH BELL-AND-SPIGOT TEE
ONE (1) 36-INCH X 30-INCH BELL-AND-SPIGOT ECCENTRIC REDUCER
ONE (1) 36-INCH X 16-INCH BELL-AND-SPIGOT ECCENTRIC REDUCER

SERVICE:

NORMAL: CARRY PUMPED ACTIVATED SLUDGE AT A MAXIMUM HEAD OF 58 FEET. CONSISTENCY OF ACTIVATED SLUDGE - 1/2-PERCENT TO 1-1/2-PERCENT SOLIDS. PH OF ACTIVATED SLUDGE - 6.5 TO 7.5. TEMPERATURE OF ACTIVATED SLUDGE 50° TO 90°F.

PRIOR TO PLANT STARTUP: THAT PORTION OF THE PIPELINE INSTALLED ON CONCRETE SUPPORTS WILL BE SUBMERSED IN HOT CAUSTIC EXTRACT (HCE) FOR AN ESTIMATED PERIOD OF 9 MONTHS. PH OF HCE - 9.0 TO 12.0. TEMPERATURE OF HCE - 50° TO 100°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED ON PREPLACED BEDDING MATERIAL AND BACKFILLED TO SPRING LINE FOR LATERAL SUPPORT FROM APPROXIMATELY STA. 0+00 TO STA. 0+21. THE PIPE WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND BACKFILLED FROM APPROXIMATELY STA. 0+31 TO STA. 2+45.

YARD PIPING SPECIFICATION SHEET NO. 12B
RETURN ACTIVATED SLUDGE TO AERATION BASIN

THE PIPE WILL BE INSTALLED ABOVE GRADE ON CONCRETE PIPE SUPPORTS AT 20-FOOT SPACING FROM APPROXIMATELY STA. 2+45 TO STA. 4+24. EXCEPT AS NOTED, EXISTING GRADE SHALL BE CONSIDERED FINAL GRADE.

REMARKS:

THE PIPELINE WILL BE INSTALLED UNDER ROADWAY FROM APPROXIMATELY STA. 2+00 TO STA. 2+45. THAT PORTION OF THE PIPELINE INSTALLED ON CONCRETE SUPPORTS WILL BE SUBJECT TO CONTINUOUS SUBAQUEOUS SERVICE: STAINLESS STEEL JOINT HARNESSES WILL BE SUPPLIED ON ALL EXPOSED JOINTS AFTER STA. 2+45.

YARD PIPING SPECIFICATION SHEET NO. 13
PRIMARY CLARIFIER EFFLUENT

DESCRIPTION:

APPROXIMATELY TWO HUNDRED ELEVEN LINEAL FEET (211') OF 48-INCH I.D. BELL-AND-SPIGOT PIPING IN A STRAIGHT ATTITUDE WITH A 13-FOOT DROP AT A 26.5-DEGREE SLOPE TOWARD ONE END OF THE RUN. EXCEPT AS NOTED, THE PIPE WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL 9-FOOT SECTION
ONE (1) BELL X SPIGOT 10-FOOT SECTION
ONE (1) BELL X SPIGOT 6-FOOT SECTION
TWO (2) BELL X SPIGOT 26.5° BENDS
ONE (1) BELL X SPIGOT 19-FOOT SECTION
ONE (1) 48-INCH X 48-INCH X 48-INCH BELL-AND-SPIGOT TEE
TWO (2) 48-INCH X 30-INCH BELL-AND-SPIGOT ECCENTRIC REDUCERS

SERVICE:

NORMAL: CARRY SULFITE PULP MILL AND PAPER MACHINE EFFLUENT (AFTER PRIMARY SEDIMENTATION) UNDER A MAXIMUM HEAD OF 25 FEET. TOTAL SUSPENDED SOLIDS IN EFFLUENT, 130 TO 530 MG/L. PH OF EFFLUENT - 3.0 TO 9.0. TEMPERATURE OF EFFLUENT - 50° TO 100°F.

PRIOR TO PLANT STARTUP: THAT PORTION OF THE PIPELINE INSTALLED ON CONCRETE SUPPORTS WILL BE SUBMERSED IN HOT CAUSTIC EXTRACT (HCE) FOR AN ESTIMATED PERIOD OF 9 MONTHS. PH OF HCE - 9.0 TO 12.0. TEMPERATURE OF HCE - 50° TO 100°F. AT STARTUP, THE PIPELINE WILL BE FLUSHED WITH SULFITE PULP MILL AND PAPER MACHINE EFFLUENT AS DESCRIBED FOR NORMAL SERVICE.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL FROM APPROXIMATELY STA. 0+06.5 TO STA. 0+38. THE PIPE WILL BE INSTALLED ABOVE GRADE ON CONCRETE PIPE SUPPORTS AT 20-FOOT SPACING FROM APPROXIMATELY STA. 0+38 TO STA. 2+18.

REMARKS:

THE PIPELINE WILL BE INSTALLED UNDER ROADWAY FROM APPROXIMATELY STA. 0+C6.5 TO STA. 0+24. THAT PORTION OF THE PIPE INSTALLED ON CONCRETE SUPPORTS WILL BE SUBJECT TO CONTINUOUS SUBAQUEOUS SERVICE. STAINLESS STEEL JOINT HARNESSES WILL BE SUPPLIED ON ALL EXPOSED JOINTS.

YARD PIPING SPECIFICATION SHEET NO. 14
RETURN ACTIVATED SLUDGE DIFFUSER - WEST ARM

DESCRIPTION:

APPROXIMATELY NINETY-SEVEN LINEAL FEET (97') OF 16-INCH I.D. BELL-AND-SPIGOT PIPING IN A STRAIGHT ATTITUDE AT A CONSTANT GRADE. EXCEPT AS NOTED, THE PIPE WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS WITH TWO 5-INCH-DIAMETER CIRCULAR PORTS AT THE SPRING LINE OF EACH PIPE SECTION. THE PORTS WILL BE ON OPPOSITE SIDES OF THE PIPE, ONE AT THE 5-FOOT POINT AND ONE AT THE 15-FOOT POINT OF EACH PIPE SECTION.

FITTINGS:

ONE (1) BELL X SPIGOT 17-FOOT SECTION WITHOUT PORTS
ONE (1) END PLUG

SERVICE:

NORMAL: CARRY PUMPED ACTIVATED SLUDGE AT A MAXIMUM HEAD OF 30 FEET. CONSISTENCY OF ACTIVATED SLUDGE - 1/2-PERCENT TO 1-1/2-PERCENT SOLIDS. PH OF ACTIVATED SLUDGE - 6.5 TO 7.5. TEMPERATURE OF ACTIVATED SLUDGE 50° TO 90°F.

PRIOR TO PLANT STARTUP: PIPELINE WILL BE SUBMERSED IN HOT CAUSTIC EXTRACT (HCE) FOR AN ESTIMATED PERIOD OF 9 MONTHS. PH OF HCE - 9.0 TO 12.0. TEMPERATURE OF HCE - 50° TO 100°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED ABOVE GRADE ON CONCRETE PIPE SUPPORTS AT 20-FOOT SPACING.

REMARKS:

THE PIPE WILL BE SUBJECT TO CONTINUOUS SUBAQUEOUS SERVICE. STAINLESS STEEL JOINT HARNESSES WILL BE SUPPLIED ON ALL JOINTS.

YARD PIPING SPECIFICATION SHEET NO. 15
RETURN ACTIVATED SLUDGE DIFFUSER - EAST ARM

DESCRIPTION:

APPROXIMATELY THREE HUNDRED TWENTY-THREE LINEAL FEET (323') OF 30-INCH I.D. BELL-AND-SPIGOT PIPING IN A STRAIGHT ATTITUDE WITH ONE VERTICAL OFFSET. EXCEPT AS NOTED, THE PIPE WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS WITH TWO 5-INCH-DIAMETER CIRCULAR PORTS AT THE SPRING LINE OF EACH PIPE SECTION. THE PORTS WILL BE ON OPPOSITE SIDES OF THE PIPE, ONE AT THE 5-FOOT POINT AND ONE AT THE 15-FOOT POINT OF EACH PIPE SECTION.

FITTINGS:

TWO (2) SPIGOT X BELL 3-FOOT SECTIONS WITHOUT PORTS
FOUR (4) SPIGOT X BELL 45° BENDS
ONE (1) SPIGOT X BELL 8-FOOT SECTION WITHOUT PORTS
ONE (1) SPIGOT X BELL 14-FOOT SECTION WITHOUT PORTS
ONE (1) END PLUG

SERVICE:

SAME AS RETURN ACTIVATED SLUDGE DIFFUSER - WEST ARM, SHEET NO. 14.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. APPROXIMATELY THREE HUNDRED SIX LINEAL FEET (306') WILL BE INSTALLED ABOVE GRADE ON CONCRETE PIPE SUPPORTS AT 20-FOOT SPACING. APPROXIMATELY SEVENTEEN LINEAL FEET (17') WILL BE INSTALLED BELOW GRADE ON BEDDING MATERIAL AND THEN BACKFILLED.

REMARKS:

THE PIPE WILL BE SUBJECT TO CONTINUOUS SUBAQUEOUS SERVICE. STAINLESS STEEL JOINT HARNESSES WILL BE SUPPLIED ON ALL JOINTS ABOVE GRADE.

YARD PIPING SPECIFICATION SHEET NO. 16
PRIMARY CLARIFIER EFFLUENT DIFFUSER

DESCRIPTION:

APPROXIMATELY FOUR HUNDRED TWENTY LINEAL FEET (420') OF 30-INCH I.D. BELL-AND-SPIGOT PIPE IN A STRAIGHT ATTITUDE AT A CONSTANT GRADE. THE PIPE WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS WITH TWO 6-INCH-DIAMETER CIRCULAR PORTS AT THE SPRING LINE OF EACH PIPE SECTION. THE PORTS WILL BE ON OPPOSITE SIDES OF THE PIPE, ONE AT THE 5-FOOT POINT AND ONE AT THE 15-FOOT POINT OF EACH PIPE SECTION.

FITTINGS:

TWO (2) END PLUGS

SERVICE:

NORMAL: CARRY SULFITE PULP MILL AND PAPER MACHINE EFFLUENT (AFTER PRIMARY SEDIMENTATION) UNDER A MAXIMUM HEAD OF 25 FEET. TOTAL SUSPENDED SOLIDS IN EFFLUENT - 130 TO 530 MB/L. PH OF EFFLUENT - 3.0 TO 9.0. TEMPERATURE OF EFFLUENT - 50° TO 100°F.

PRIOR TO PLANT STARTUP: PIPELINE WILL BE SUBMERSED IN HOT CAUSTIC EXTRACT (HCE) FOR AN ESTIMATED PERIOD OF 9 MONTHS. PH OF HCE - 9.0 TO 12.0. TEMPERATURE OF HCE - 50° TO 100°F. AT STARTUP, THE PIPELINE WILL BE FLUSHED WITH SULFITE PULP MILL AND PAPER MACHINE EFFLUENT AS DESCRIBED FOR NORMAL SERVICE.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPE WILL BE INSTALLED ABOVE GRADE ON CONCRETE PIPE SUPPORTS AT 20-FOOT SPACING.

REMARKS:

THE PIPE WILL BE SUBJECT TO CONTINUOUS SUBAQUEOUS SERVICE. STAINLESS STEEL JOINT HARNESSES WILL BE SUPPLIED ON ALL JOINTS.

YARD PIPING SPECIFICATION SHEET NO. 17
NORTH SECONDARY CLARIFIER WAS

DESCRIPTION:

APPROXIMATELY ONE HUNDRED TWNETY-FIVE LINEAL FEET (125') OF 8-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL BENDS AND ONE VERTICAL BEND. THE PIPE WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

THREE (3) SPIGOT X BELL 45° BENDS
ONE (1) SPIGOT X BELL 8° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 3-FOOT SECTION

SERVICE:

CARRY WASTE ACTIVATED SLUDGE UNDER A MAXIMUM HEAD OF 25 FEET. CONSISTENCY OF WASTE SLUDGE - 1/2-PERCENT TO 1-1/2-PERCENT SOLIDS. PH OF WASTE SLUDGE - 6.5 TO 7.5. TEMPERATURE OF WASTE SLUDGE - 50° TO 90°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPING WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. DEPTH OF COVER WILL VARY FROM 3 TO 5 FEET.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FOR APPROXIMATELY 60 FEET IN LENGTH.

YARD PIPING SPECIFICATION SHEET NO. 18
WEST SECONDARY CLARIFIER WAS

DESCRIPTION:

APPROXIMATELY THIRTY-THREE LINEAL FEET (33') OF 8-INCH I.D. BELL-AND-SPIGOT PIPING WITH ONE HORIZONTAL OFFSET AND AT A CONSTANT GRADE. THE PIPE WILL BE SUPPLIED AS NOTED. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

ONE (1) SPIGOT X BELL 4-FOOT SECTION
TWO (2) SPIGOT X BELL 45° BENDS
ONE (1) SPIGOT X BELL 3-FOOT SECTION
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 23-FOOT SECTION

SERVICE:

SAME AS NORTH SECONDARY CLARIFIER WAS, SHEET NO. 17.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPING WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. DEPTH OF COVER WILL VARY FROM 4 TO 6 FEET.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FOR APPROXIMATELY 25 FEET IN LENGTH.

YARD PIPING SPECIFICATION SHEET NO. 19
SOUTH SECONDARY CLARIFIER WAS

DESCRIPTION:

APPROXIMATELY NINETY-SIX LINEAL FEET (96') OF 8-INCH I.D. BELL-AND-SPIGOT PIPING WITH ONE HORIZONTAL BEND AND AT A CONSTANT GRADE. EXCEPT AS NOTED, THE PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE. PIPING UNDER THE CLARIFIER WILL NOT BE INCLUDED.

FITTINGS:

ONE (1) SPIGOT X BELL 25° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) PIPE SECTION

SERVICE:

SAME AS NORTH SECONDARY CLARIFIER WAS, SHEET NO. 17.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPING WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. DEPTH OF COVER WILL VARY FROM 5 TO 16 FEET.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FOR APPROXIMATELY 52 FEET IN LENGTH.

YARD PIPING SPECIFICATION SHEET NO. 20
WASTE ACTIVATED SLUDGE TO JUNCTION STRUCTURE

DESCRIPTION:

APPROXIMATELY ONE HUNDRED SEVENTEEN LINEAL FEET (117') OF 10-INCH I.D. BELL-AND-SPIGOT PIPING WITH ONE HORIZONTAL AND ONE VERTICAL BEND. THE PIPING WILL BE SUPPLIED IN RANDOM 20-FOOT LENGTHS.

FITTINGS AND SPECIALS:

TWO (2) FLANGED (FACTORY ATTACHED) X BELL SECTIONS
ONE (1) 10-INCH X 10-INCH X 10-INCH BELL-AND-SPIGOT TEE
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 10-FOOT SECTION
ONE (1) SPIGOT X BELL 5.5° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) SECTION

SERVICE:

CARRY PUMPED WASTE ACTIVATED SLUDGE UNDER A MAXIMUM HEAD OF 40 FEET. CONSISTENCY OF WASTE SLUDGE - 1/2-PERCENT TO 1-1/2-PERCENT SOLIDS. PH OF WASTE SLUDGE - 6.5 TO 7.5. TEMPERATURE OF WASTE SLUDGE - 50°. TO 90°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPING WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. DEPTH OF COVER WILL VARY FROM 3 TO 6 FEET.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FOR APPROXIMATELY 100 FEET IN LENGTH.

YARD PIPING SPECIFICATION SHEET NO. 21
WASTE ACTIVATED SLUDGE TO THICKENED SLUDGE PUMP STATION

DESCRIPTION:

APPROXIMATELY TWO HUNDRED FOUR LINEAL FEET (204') OF 10-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL BENDS AND AT A CONSTANT GRADE. EXCEPT AS NOTED, THE PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE.

FITTINGS:

TWO (2) SPIGOT X BELL 45° BENDS
ONE (1) SPIGOT X BELL 20° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) SECTION

SERVICE:

SAME AS WASTE ACTIVATED SLUDGE TO JUNCTION STRUCTURE, SHEET NO. 20.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPING WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. DEPTH OF COVER WILL VARY FROM 3 TO 4 FEET.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FOR APPROXIMATELY 70 FEET IN LENGTH.

YARD PIPING SPECIFICATION SHEET NO. 22
THICKENER SUPERNATANT FROM THICKENED SLUDGE PUMP STATION

DESCRIPTION:

APPROXIMATELY THREE HUNDRED FORTY-TWO LINEAL FEET (342') OF 8-INCH I.D. BELL-AND-SPIGOT PIPING WITH SEVERAL HORIZONTAL AND VERTICAL BENDS. EXCEPT AS NOTED, THE PIPING WILL BE SUPPLIED IN THE LONGEST RANDOM LENGTHS POSSIBLE.

FITTINGS:

ONE (1) FLANGED (FACTORY ATTACHED) X BELL SECTION
TWO (2) SPIGOT X BELL 90° BENDS
ONE (1) SPIGOT X BELL 45° BEND
ONE (1) SPIGOT X BELL 82° BEND
ONE (1) SPIGOT X BELL 3° BEND
ONE (1) SPIGOT X BELL 5° BEND
ONE (1) SPIGOT X BELL 66° BEND
ONE (1) SPIGOT X FLANGED (FACTORY ATTACHED) 90° BEND

SERVICE:

CARRY PUMPED SUPERNATANT FROM A GRAVITY THICKENER AT A MAXIMUM HEAD OF 50 FEET. TOTAL SUSPENDED SOLIDS IN SUPERNATANT WILL BE MINIMAL. PH OF SUPERNATANT - 6 TO 9. TEMPERATURE OF SUPERNATANT - 50° TO 85°F.

INSTALLATION:

FIELD JOIN PIPING, AS RECEIVED, BY MANUFACTURER'S RECOMMENDED METHOD. THE PIPING WILL BE INSTALLED BELOW GRADE ON PREPLACED BEDDING MATERIAL AND THEN BACKFILLED. DEPTH OF COVER WILL VARY FROM 3 TO 7 FEET.

REMARKS:

THE PIPELINE WILL BE PLACED UNDER ROADWAY FOR APPROXIMATELY 15 FEET IN LENGTH.

VITA

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Experience:	Civil Engineering Technician Aide, March 1969-September 1969; Civil Engineering Technician I, March 1970-September 1970; Civil Engineering Technician II, March 1971-September 1971; Civil Engineering Technician III, June 1972-December 1972; Civil Engineer I, December 1972-September 1974; Civil/Sanitary Engineer II, June 1975-December 1976; Civil/Sanitary Engineer III, January 1977-December 1979; Civil/Sanitary Engineer IV and Regional Discipline Coordinator, January 1980-January 1981; All with CH_2M HILL, Inc., Seattle (Bellevue), Washington
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The typist for this report was Joyce Hyden.